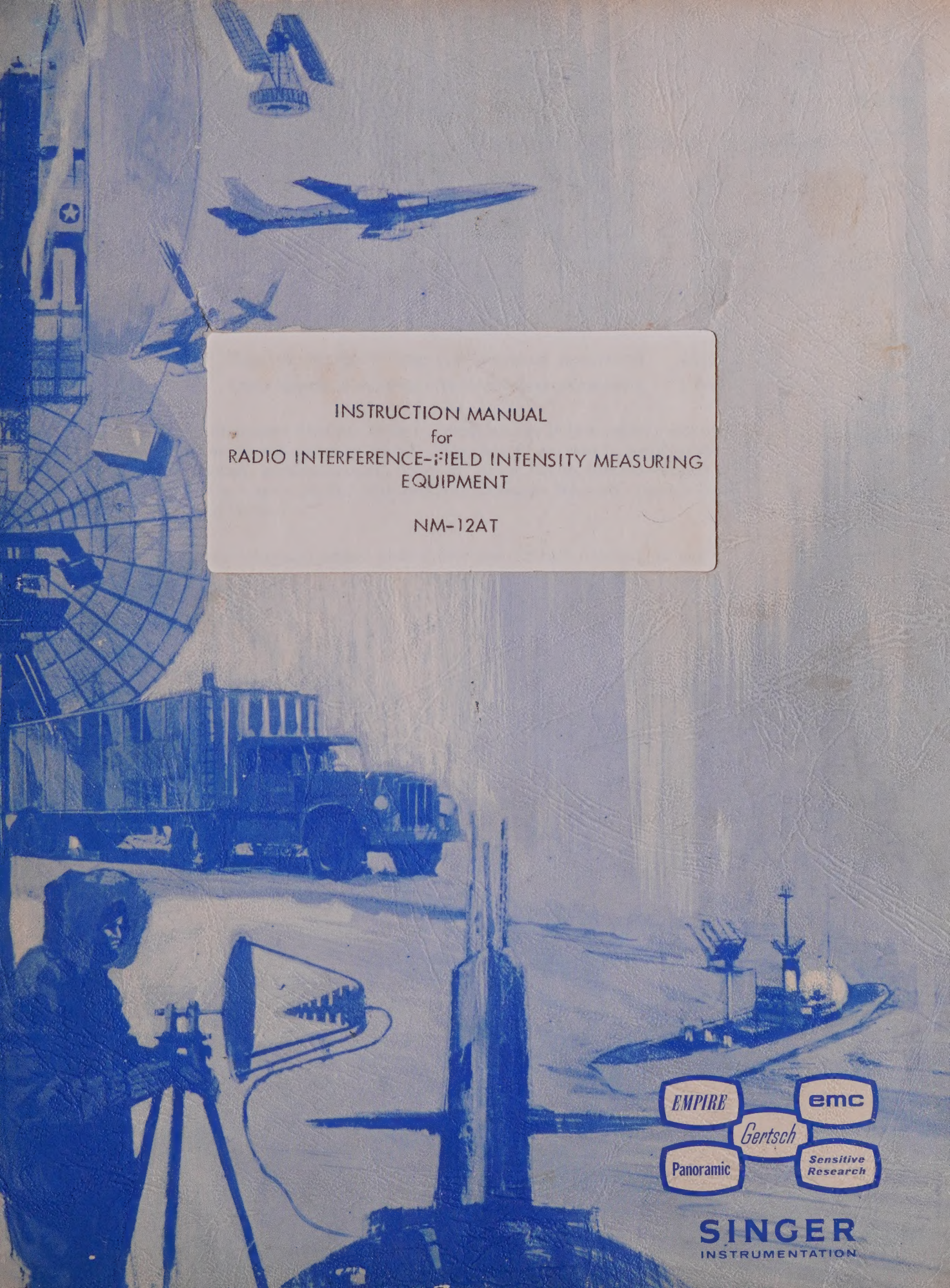

INSTRUCTION MANUAL
for
RADIO INTERFERENCE-FIELD INTENSITY MEASURING EQUIPMENT

NM-12AT

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SINGER
INSTRUMENTATION

INSTRUCTION MANUAL
for
RADIO INTERFERENCE-FIELD INTENSITY MEASURING EQUIPMENT

NM-12AT

The Singer Company, Electronic Products Division
Gertsch Operation

Manual No. 41006 9/1/68

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2. Serial Number
3. Description of trouble[2]
4. Test instruments used
5. Approximate date instrument was placed in operation
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7. Has maintenance action been previously requested?
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(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

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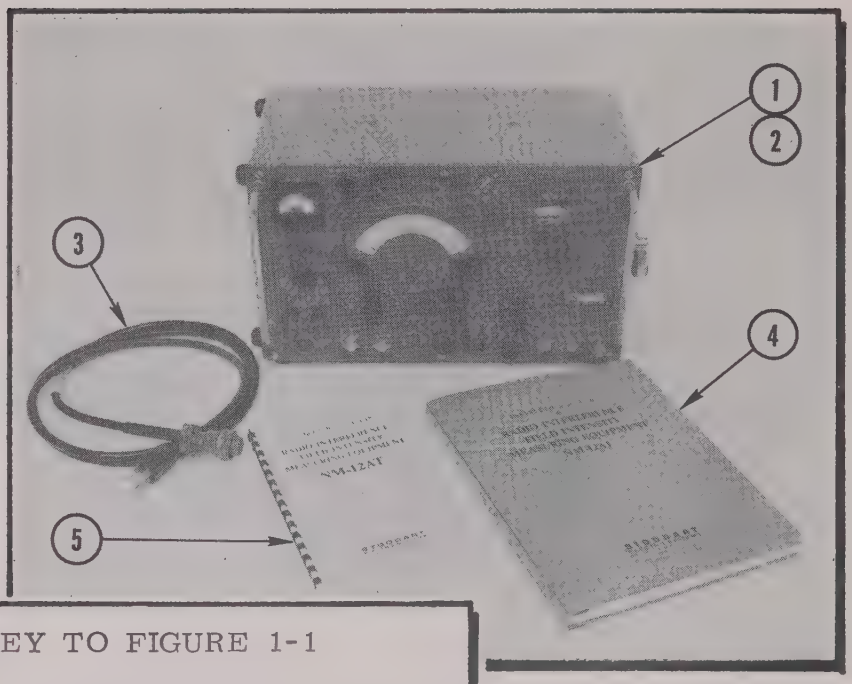


KEY TO FIGURE 1-1

1. NM-12AT RFI METER
2. BATTERY PACK (INSIDE #1)
3. AC POWER CABLE, 6-FOOT
4. INSTRUCTION MANUAL
5. CALIBRATION FIGURE CHARTS

Figure 1-1. STODDART Model NM-12AT Radio Interference and Field Intensity Measuring Set

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1.1 INTRODUCTION

1.2 SCOPE

This manual contains operation and maintenance instructions for the Model NM-12AT Radio Interference and Field Intensity Measuring Set, manufactured by STODDART ELECTRO SYSTEMS, Gardena, California 90249. The manual is divided into six sections; i.e., Description and Leading Particulars, Preparation for Operation, Operating Instructions, Principles of Operation, Maintenance, and Parts List.

1.3 PURPOSE

The STODDART Model NM-12AT Radio Interference and Field Intensity Measuring Set, Figure 1-1, (hereafter referred to as the RFI Meter), is a precision test instrument for the measurement and analysis of either conducted or radiated RF energy between 10 and 250 kHz. The RFI Meter, together with available accessory items, is extremely versatile and may be used in a variety of applications; a few of these are as follows:

a) To conduct radio frequency interference surveys; locating the source and/or analyzing the nature of conducted and radiated interference.

b) To perform field intensity measurements; assisting in the adjustment of VLF antennas, or to determine radiation patterns where field strengths may vary widely.

c) As a calibrated, tunable, two-terminal RF voltmeter for laboratory measurements.

d) As a sensitive and selective, portable, VLF communications receiver.

1.4 FUNCTIONAL DESCRIPTION

1.5 RFI METER

The NM-12AT RFI Meter is basically a single conversion superheterodyne radio receiver, covering the range of 10 to 250 kHz in four bands. The RFI Meter has an input impedance of 50 ohms, and when used as a two-terminal RF voltmeter provides a measurement range of 0.01 microvolts to 1.0 volt. The inclusion of several special purpose circuits within the instrument provides additional measurement functions not possible with conventional receivers. These circuits, and their functions are as follows:

a) ATTENUATOR: A step-type attenuator (RF and IF) permits accurate signal level measurements up to 120 dB above one microvolt.

b) CALIBRATOR: An internal impulse generator permits the overall gain of the receiver to be standardized at the measurement frequency.

c) DETECTOR FUNCTIONS: Selectable detector time constants permit the measurement of average, weighted, or peak signal levels.

1.6 The RFI Meter employs solid-state circuitry throughout, and modular construction (including printed circuits) is used for all major sub-assemblies. A self-contained rechargeable battery provides completely portable operation, and an internal charging circuit is included, operating from any 105 to 125, or 210 to 250 volts, 50 to 400 Hz source.

1.7 MEASUREMENT FUNCTIONS

The RFI Meter provides three basic measurement functions. These, selected by the front panel FUNCTION switch, are as follows:

a) FIELD INTENSITY: The field intensity (FI) position is used in the measurement of average signal values; i.e., the average carrier level of narrowband signals. This function can also be used to observe the modulation envelope of a signal with an external oscilloscope.

b) QUASI PEAK: The quasi peak (QP) position is used in the measurement of "weighted" signal values (refer to Section IV for a definition of the term "weighted" signal). This function is used with narrowband signals when the carrier level (either modulated or unmodulated) is to be measured.

c) PEAK: The PEAK position is used in the measurement of peak signal values. This function is used principally in the measurement of broadband interference.

d) The FUNCTION switch has two additional positions; i.e., BFO and CAL. The BFO position permits audible reception of CW type signals, while the CAL position permits the receiver gain to be standardized.

1.8 OUTPUTS

The various RFI Meter outputs may be monitored at the front panel receptacles. AUDIO, IF OUTPUT, SCOPE, and both X and Y-OUTPUT receptacles are provided.

1.9 EQUIPMENT SUPPLIED

1.10 The equipment supplied is illustrated in Figure 1-1, and tabulated in Table 1-1.

TABLE 1-1. Equipment Supplied

ITEM	STODDART NUMBER	DESCRIPTION
1.	NM-12AT	Radio Interference-Field Intensity Meter, 10 to 250 kHz, includes:
2.	93861-1	Battery Pack
3.	91258-1	AC Power Cable, six-foot
4.	41006-1	Instruction Manual
5.	21567-1	Calibration Figure Chart

1.11 ELECTRICAL CHARACTERISTICS

1.12 FREQUENCY RANGE

The frequency range is 10 to 250 kHz in four bands, as follows:

BAND	FREQUENCY COVERAGE
1.	10 to 22.5 kHz
2.	22.5 to 50 kHz
3.	50 to 112 kHz
4.	112 to 250 kHz

1.13 TYPE OF RECEIVER

Single conversion superheterodyne.

1.14 INTERMEDIATE FREQUENCY

The intermediate frequency is 455 kHz.

1.15 SIGNAL CAPABILITIES

CW or amplitude modulated carrier; pulse, impulse, or random interference.

1.16 INPUT IMPEDANCE

50 ohms (coaxial) with an input VSWR less than 1.2:1.

1.17 ATTENUATOR RANGE

The attenuator range (RF and IF) is as follows:

SWITCH POSITION	ATTENUATION (dB) RF	IF	METER READING (dB ABOVE 1 uV) MIN	MAX
-40 dB/ X0.01	0	0	-40	0
-20 dB/ X0.1	0	20	-20	+20
0 dB/ X1.0	20	20	0	+40
+20 dB/ X10	40	20	+20	+60
+40 dB/ $X10^2$	60	20	+40	+80
+60 dB/ $X10^3$	80	20	+60	+100
+80 dB/ $X10^4$	100	20	+80	+120

NOTE

The IF attenuation is 20 dB with the FUNCTION switch in the CAL position.

1.18 SENSITIVITY

The sensitivity depends on the use, input device, and frequency, as follows:

a) 50-OHM TWO-TERMINAL RF VOLTMETER:

1. For narrowband measurements the sensitivity is 0.01 microvolt for unity signal to noise ratio (40 dB below one microvolt).

2. For broadband measurements the sensitivity is 50 microvolts/MHz for unity signal to noise ratio (34 dB above one microvolt/MHz).

b) FIELD INTENSITY METER: The sensitivity varies with frequency and input device:

1. For narrowband measurements with the one-meter Rod Antenna (92222-2) the sensitivity is 0.4 to 5.6 microvolts/meter (-7 to +15 dB above one microvolt/meter).

2. For broadband measurements with the one-meter Rod Antenna the sensitivity is 1.4 to 20 millivolts/meter/MHz (63 to 86 dB above one microvolt/meter/MHz.

3. For narrowband measurements with the Collapsible Loop Antenna (92938-2) the sensitivity is 3 to 14 microvolts/meter (9 to 23 dB above one microvolt/meter).

4. For broadband measurements with the Collapsible Loop Antenna the sensitivity is 10 millivolts/meter/MHz to 50 millivolts/meter/MHz (80 to 94 dB above one microvolt/meter/MHz).

1.19 BANDWIDTH

Two IF bandwidths are available, selected by the BANDWIDTH switch position, as follows:

SWITCH POSITION	6 dB	60 dB	RANDOM NOISE	IMPULSE NOISE
NARROW	100 Hz, ±5%	500 Hz	90 Hz	110 Hz
BROAD	2.45 kHz, ±10%	12 kHz	2 kHz	2.7 kHz

1.20 SPURIOUS RESPONSE REJECTION

IF rejection is better than 100 dB, image rejection is better than 80 dB and all other spurious response rejection is better than 60 dB.

1.21 LOCAL OSCILLATOR RADIATION

Less than 50 picowatts.

1.22 SHIELDING EFFECTIVENESS

Better than 80 dB

1.23 DYNAMIC RANGE

18 dB (±2 dB) above full-scale meter deflection.

1.24 CALIBRATION

Internal impulse generator with a fixed repetition rate of 28 PPS and spectral output constant over entire frequency range.

1.25 MEASUREMENT FUNCTIONS

Three, as follows:

a) FIELD INTENSITY: 600 millisecond charge and discharge time.

b) QUASI PEAK: One millisecond charge, 600 milliseconds discharge time.

c) SLIDEBACK PEAK: Manually controlled; visual indicator employs a movable "white bar" meter, aural indication by headset.

1.26 MEASUREMENT ACCURACY

Frequency (as read on dial) is within ±2%; voltage measurements are within ±2.0 dB.

1.27 PANEL METER

Four-inch scale length; calibrated in two decade approximately logarithmic from 1 to 100 microvolts, and approximately linear from 0 to 40 dB.

1.28 OUTPUTS

Five, as follows:

a) AUDIO: Headset receptacle; 600-ohm impedance; output power 25 milliwatts; frequency response of audio section flat within ±3 dB from 250 to 2500 Hz.

b) IF OUTPUT: BNC coaxial receptacle; 50-ohm 455 kHz IF output at 0.1 volt RMS.

c) SCOPE: BNC coaxial receptacle; approximately 500 kilohms oscilloscope output; output voltage varies with percentage of modulation (nominally 400 millivolts peak-to-peak for a 30-percent modulated signal at full-scale indication); frequency response of post detector section flat within ±6 dB from 100 to 2500 Hz.

d) X-OUTPUT: BNC coaxial receptacle; approximately one-volt DC for maximum dial rotation.

e) Y-OUTPUT: Two-pole receptacle for remote meter, or a graphic recorder; 1500-ohm output impedance; output current one milliampere maximum.

1.29 POWER SOURCE

Internal rechargeable 12 cell NiCa battery; 15 volts nominal terminal voltage:

a) CELL TYPE: Sonotone Type S104; "C" size.

b) CAPACITY: 1.9 ampere-hour; provides 40 hours operating time without recharging (14 to 17 volts DC operating voltage).

c) REGULATOR: An internal regulator circuit provides 12 volts, ±0.1 volt, DC to the RFI Meter.

d) VOLTAGE MONITOR: Panel BATTERY meter, provided with a 12 to 17 volt expanded scale.

1.30 BATTERY CHARGER

Internal:

a) POWER SOURCE: 105 to 125, or 210 to 250 volts, 50 to 400 Hz.

b) POWER CONSUMPTION: 5 watts.

c) CHARGING CURRENT: 150 milliamperes maximum when the battery is fully discharged; 40 to 60 milliamperes trickel charge when the battery is fully charged.

d) CHARGING TIME: 30 hours with RFI Meter not operating; 44 hours with RFI Meter "ON".

1.31 PHYSICAL CHARACTERISTICS

1.32 DIMENSIONS

The Model NM-12AT RFI Meter dimensions are shown in Figure 1-2.

1.33 WEIGHT

The Model NM-12AT RFI Meter weights 22-1/2 lbs with batteries installed.

1.34 ACCESSORY ITEMS

1.35 The various accessory items available for use with the NM-12AT RFI Meter are tabulated in Table 1-2. The major accessories are also described and illustrated in the following paragraphs.

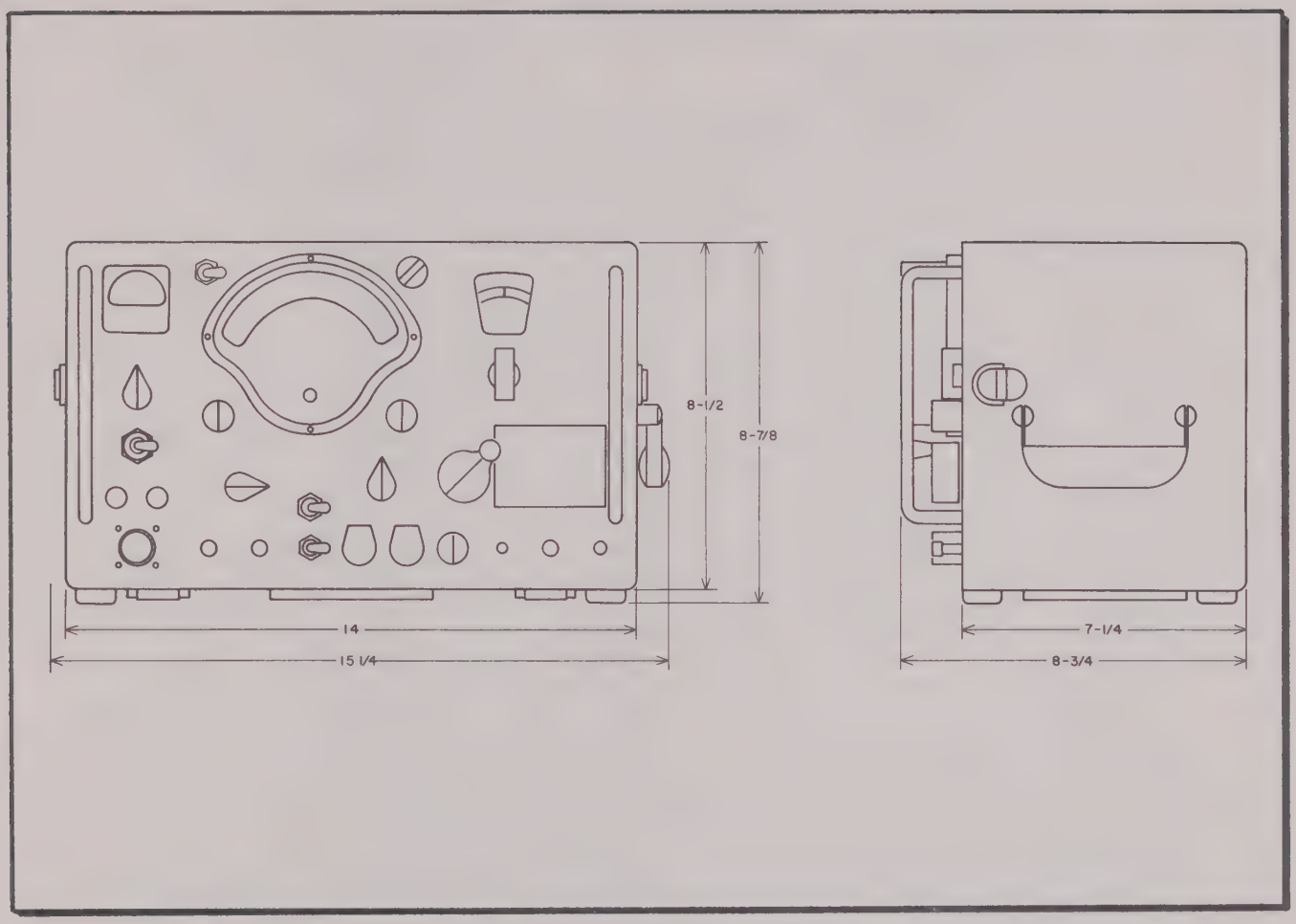


Figure 1-2. Model NM-12AT RFI Meter, Outline and Dimension Drawing

TABLE 1-2. Accessory Items

ITEM	STODDART NUMBER	DESCRIPTION
1	92191-1	RF Transmission Line, 20-foot
2	92191-2	RF Transmission Line, two-foot
3	92221-2	Rod Antenna, 53-inch
4	92222-2	Rod Antenna, 86-inch
5	92943-1	Rod Antenna Coupler
6	92199-3	Ground Plane (used with 92221-2 or 92222-2 and 92943-1)
7	92938-2	Loop Antenna Coupler, and Collapsible Loop Antenna
8	93410-1	Antenna Coupler Adapter
9	90081-4	Impedance Matching Network, Hi-Z to 50 ohms
10	91197-1	RF Current Probe, 30 Hz to 5 MHz (1-1/4 inch "window")
11	91550-1	RF Current Probe, 30 Hz to 100 MHz (1-1/4 inch "window")
12	93686-1	RF Current Probe, 30 Hz to 30 MHz (2-5/8 inch "window")
13	93686-2	RF Current Probe, 30 Hz to 50 MHz (2-5/8 inch "window")
14	11663	Coaxial Connector (N to BNC)
15	90799-3	Loop Probe
16	10796	Headphones
17	90078-13	Remote Meter
18	90075-2	Remote Meter Cable, 20- foot
19	90071-1	Oscilloscope Cable
20	90074-1	Headphone Extension Cable, 20-foot
21	90075-4	"Y" Output Cable, six-foot
22	91933-2	Tripod
23	92049-1	Tripod Bag
24	93854-1	Meter Transit Case
25	92220-5	Accessory Case

TABLE 1-2. Accessory Items (Continued)

ITEM	STODDART NUMBER	DESCRIPTION
26	91981-2	Cable Bag
27	93453-1	Impulse Generator
28	APC-10B	Auto-Plot Controller, Includes:
	40326-1	Instruction Manual
	93843-1	AC Power Cable
	93828-2	Flexible Drive Cable Assembly, 36-inch
	-------	X-Y Plotter Cable Set (type selected by user)
29	25A(B)	X-Y Plotter (for use with APC-10B)
30	91987-2	Graphic Milliammeter Recorder 60 Hz
31	90075-1	Recorder Cable, six-foot

1.36 INPUT DEVICES

The various input devices available are as follows:

a) ROD ANTENNAS: There are two Rod Antennas available; the 53-inch (92221-2) and 86-inch (92222-2). Both antennas are of telescopic construction for convenience in handling and transit. These antennas are used for radiated electric field measurements, and in use are mounted on the Rod Antenna Coupler (92943-1). The 86-inch antenna is referred to as the "one-meter effective height rod", and the 53-inch antenna as the "half-meter effective height rod".

b) ROD ANTENNA COUPLER: The Rod Antenna Coupler (92943-1) contains selectable circuits that match the high impedance of the rod antennas to the 50-ohm input of the RFI Meter over the complete frequency range of the equipment. The rod antenna and coupler may be mounted on top of the RFI Meter, using the Antenna Coupler Adapter (93410-1), or may be used in conjunction with the Ground Plane (92199-3), and mounted on the Tripod (91933-2).

c) LOOP ANTENNA: The Collapsible Loop Antenna is used for radiated magnetic field measurements. The antenna consists of the Loop Antenna Coupler (92938-2), a mast section, three arms, and a length of coaxial cable. The loop antenna may be mounted on top of the RFI Meter, using the Antenna Coupler Adapter (93410-1), or on the Tripod (91933-2) for remote measurements.

d) LOOP ANTENNA COUPLER: The Loop Antenna Coupler (92938-2) contains selectable circuits that match the low impedance of the loop antenna (or Loop Probe) to the 50-ohm input of the RFI Meter over the complete frequency range of the equipment.

e) LOOP PROBE: The Loop Probe (90799-3) is used for radiated magnetic field measurements. This is a small hand held probe, and provides comparative measurements only. The probe is normally used in conjunction with the 20-foot RF Transmission Line (92191-1), with the Loop Antenna Coupler (92938-2) mounted on top of the RFI Meter.

f) RF CURRENT PROBES: There are four RF Current Probes available for use with the NM-12AT (91197-1, 91550-1, 93686-1, and 93686-2). These are "clamp-on" RF current transformers, and are used for conducted RF interference measurements.

g) IMPEDANCE MATCHING NETWORK: The Impedance Matching Network (90081-4) is used in conjunction with the Rod Antenna Coupler (92943-1) to match the high impedance output of certain devices to the 50-ohm input of the RFI Meter. This is useful where the source is a signal generator, or other device whose output is not meant to be terminated in a low resistance.

1.37 OUTPUT DEVICES

The various accessory output devices available, are as follows:

a) REMOTE METER: The Remote Meter (90078-13) is identical electrically with the one on the front panel of the RFI Meter, and provides the same scales; i.e., two decade approximately logarithmic from 1 to 100 microvolts, and approximately linear from 0 to 40 dB. The Remote Meter and Remote Meter Cable (90075-2) permit visual signal measurement or monitoring at distances up to 20 feet from the RFI Meter. In use, the Remote Meter does not disable, or affect the measurement accuracy of the normal panel meter.

b) RECORDER: The Graphic Milliammeter Recorder (91987-2) provides a permanent chart recording of RFI (or other signal) level measurements. These can be made without disabling or disturbing the front panel meter indication. The recorder may be used up to six feet from the RFI Meter, and is connected with the "Y" Output Cable (90075-4). Provision is included for chart speeds of 3/4, 1-1/2, 3, 6, and 12 inches per hour or per minute. The recorder operates from 115 volts 60 Hz only.

1.38 ACCESSORY MEASUREMENT AND AUTOMATION DEVICES

There are several accessory measurement and automation devices available for use with the NM-12AT RFI Meter. These extend the normal versatility of the equipment in both making RFI measurements, and also in many laboratory application. A description of these items, together with some of their applications follows:

a) IMPULSE GENERATOR: The Model 93453-1 Impulse Generator provides a wideband spectral output adjustable in 0.25 dB steps to 121 dB above one microvolt/MHz. The unit provides a useful output from DC through 400 MHz, and is flat within ± 1.0 dB from 500 Hz to 35 MHz. The pulse rate is adjustable from 2 to 100 pps and provision is included for single pulse triggering. The Model 93453-1 is especially useful in the calibration of RFI instrumentation, and also as a broadband signal source in conducting substitution-type measurements of impulse signals. The generator operates from any 105 to 125 volt 60 Hz source, and requires 20 watts of power.

b) AUTO-PLOT CONTROLLER: The Model APC-10 Auto-Plot Controller provides automated RFI recordings of receiver frequency vs. peak interference, or signal amplitudes. The APC-10 operates in a system configuration, with the RFI Meter as the input device, and an X-Y plotter as the data reduction device. The APC-10 provides a mechanical tuning drive to the RFI Meter and produces a frequency axis analog voltage, applied to the X-input of the plotter to record the frequency scanned. The IF output of the RFI Meter is applied to the APC-10, where the signals are amplified and peak detected, then applied to the Y-input of the plotter to record the "peak" signal amplitudes. Although designed primarily for RFI recordings, the APC-10 is also suitable for a wide range of laboratory and field applications. These include site selection surveys; antenna pattern measurements; emission spectra measurements; shielded enclosure attenuation tests; spectrum signature measurements and activity monitoring, or searches; receiver selectivity measurements; signal stability measurements; filter frequency response tests; attenuator frequency-loss measurements, etc. The APC-10 operates from any 105 to 125 volt, 50 to 60 Hz source, and requires 250 watts of power (including the X-Y Plotter).

c) X-Y PLOTTER: The Model 25 X-Y Plotter is specifically designed for operation in conjunction with the APC-10 Auto-Plot Controller for automated RFI recording. The plotter is of a two-axis servo-driven type, with a horizontal movement of the carriage track and a vertical movement of the writing pen in this track. The plotter obtains operating power from the APC-10 during use.

1.39 CARRYING CASES

There are four carrying cases and equipment bags available, as follows:

a) METER TRANSIT CASE; The Meter Transit Case (93854-1) protects the RFI Meter during transit and/or storage. The case accommodates the RFI Meter, AC Power Cable, Instruction Manual, and Calibration Figure Chart. The overall dimensions are 17-1/2 by 10 by 11-1/2 inches, and the case weighs 30 lbs. when filled.

b) ACCESSORY CASE: The Accessory Case (92220-5) protects the operating accessories during transit and/or storage. The case overall dimensions are 21-1/2 by 18 by 6 inches, and weighs 18 lbs. when filled.

c) CABLE BAG: The Cable Bag (91981-2) protects the various cables during transit and/or storage. The bag overall dimensions are 16-1/2 inches diameter, by 8 inches high, and weighs 9 lbs. when filled.

d) TRIPOD BAG: The Tripod Bag (92049-1) protects the Tripod (91933-2) during transit and/or storage. The bag overall dimensions are 6-1/2 inches diameter, by 38 inches high, and weighs 8-1/2 lbs. when filled.

SECTION II

PREPARATION FOR OPERATION

2.1 GENERAL

2.2 This section describes preparation of the STODDART Model NM-12AT RFI Meter for the measurement of conducted or radiated RF signals. Operating instructions for the equipment are covered in Section III.

2.3 SELECTION OF A MEASUREMENT LOCATION

2.4 Radio frequency interference (RFI) or field intensity measurements often must be made at a designated location. Under these circumstances the operator must be aware of the effects on the signal being measured from surrounding terrain, or nearby metallic objects. However, in a case where the site can be chosen, the operator must know how to select the best location for a particular type of measurement.

2.5 Regardless of where the measurements are made, the RFI Meter will indicate the true field intensity at that location. To obtain best results, the measurement site must be as far as possible from sources of spurious electromagnetic interference. Also, the greatest accuracy is obtained when the RFI Meter antenna is at least two wavelengths from the source of radiation to be measured. Otherwise, the accuracy may be affected by induction components being superimposed upon the radiation component.

2.6 When selecting a measurement site, the operator must realize that the amplitude of the RF voltage induced into the rod or loop antenna will be directly proportional to the field intensity of the radiated electromagnetic field-----in the space occupied by the antenna. The rod and loop antennas only respond to the vertical component of the electromagnetic field, and are therefore calibrated in terms of the vertical component. However,

once the site is decided upon, the measured field intensity is governed by the following factors:

a) The output power of the radiating source.
b) The directional characteristics of the radiating source.
c) The frequency of the radiation.
d) The distance between the radiating source, and the RFI Meter antenna.
e) The absorption and reflections from the earth, atmosphere, or nearby objects.

2.7 SETTING UP THE EQUIPMENT

2.8 BASIC TEST CONFIGURATIONS

The STODDART Model NM-12AT RFI Meter is an extremely versatile test instrument, and may be connected with its accessory items in various configurations. The following, however, are considered the basic test configurations:

a) The RFI Meter can be mounted on the Tripod (91933-2), and either a Rod Antenna (92221-2 or 92222-2) and Antenna Coupler (92943-1), or the Collapsible Loop Antenna (92938-2), may be mounted on top of the RFI Meter with the Antenna Coupler Adapter (93410-1).
b) The RFI Meter can be placed on a bench, or other flat surface, and the Rod Antenna and Antenna Coupler installed on the Ground Plane (92199-3). The Ground Plane can then be mounted on the Tripod, and located up to 20 feet from the RFI Meter. If the Collapsible Loop Antenna is used, it may be mounted directly on the Tripod.
c) The RFI Meter can be connected to 50-ohm, high impedance, or Current Probe input sources for the measurement of conducted signals. It can also be connected to a Loop Probe (90799-3) input device to detect radiation leakage from shielded enclosures.

2.9 POWER REQUIREMENTS

The RFI Meter normally operates from an internal rechargable battery, both during portable use, and also when connected to an external AC power source. When an external AC power source is used, the battery will charge during normal operation, and also if desired, with the RFI Meter turned "OFF". In addition, the RFI Meter may be operated from the internal battery charger with the battery removed from the equipment.

a) BATTERY: The internal 12-cell Nickel Cadmium battery is contained in an aluminum case in the power supply section. The BATTERY meter monitors the battery voltage when the POWER switch is in the CHARGE or ON positions. The RFI Meter can be operated for approximately 40 hours from a fully charged battery before necessity for recharging.

b) BATTERY CHARGER: The battery charger operates from any single-phase AC power source of 105 to 125, or 210 to 250 volts, 50 to 400 Hz. A charge regulating circuit is indluded to prevent overcharging, by maintaining the charging current within rated values.

2.10 PREPARING THE RFI METER FOR USE

2.11 MOUNTING

Mount the RFI Meter on the Tripod (91933-2), or place it on a bench or other flat surface.

2.12 ADJUSTING THE TRIPOD

Adjust the Tripod (91933-2) as follows:

a) Loosen the lower knobs on all three legs, and adjust the extension sections for the desired height.

b) Tighten the lower knobs to lock the extension sections in place.

c) Loosen the upper knobs on all three legs, and spread the legs to the position that provides greatest stability.

d) Tighten the upper knobs to lock the legs in place.

2.13 POWER CONNECTION

If an external source of 105 to 125, or 210 to 250 volts, 50 to 400 Hz is available, the RFI Meter can be connected to the power source as follows:

a) Set the 105V-125V/210V-250V switch on the front panel to the position corresponding to the available line voltage.

NOTE

To change the switch position, first remove the screw and guard bracket; change the position; then re-install the bracket on the opposite side, tighten the screw as necessary.

b) Connect the six-foot AC Power Cable (91258-1) to the POWER receptacle on the front panel. Connect the other end to the AC power source.

2.14 RF TRANSMISSION LINE

Either the two-foot (92191-2) or 20-foot (92191-1) RF Transmission Line may be used. Both are coaxial cables, having BNC type connectors at each end. The two-foot cable is used when either the rod or loop antenna is mounted on top of the RFI Meter. The 20-foot cable is used when either the rod or loop antenna is mounted on the Tripod (91933-2), or where other remote pickup devices; i.e., RF Current Probes, etc., are used.

CAUTION

The total DC plus RF power across the RF INPUT must not exceed 0.5 watt, or the RFI Meter will be severely damaged.

2.15 PREPARATION FOR RADIATED MEASUREMENTS

The NM-12AT RFI Meter and accessories may be connected for radiated measurements using the Collapsible Loop Antenna, Loop Probe, or the 53-inch or 86-inch Rod Antennas.

2.16 COLLAPSIBLE LOOP ANTENNA

The Collapsible Loop Antenna (92938-2) consists of a Loop Antenna Coupler, mast section, three arms, and a length of coaxial cable (that forms the loop). The Loop Antenna Coupler matches the low impedance of the Collapsible Loop Antenna (or the 90799-3 Loop Probe) to the 50-ohm input impedance of the RFI Meter in each of the four bands.

2.17 ASSEMBLING THE LOOP ANTENNA

Assemble the Collapsible Loop Antenna (92938-2) as follows:

a) Attach the Antenna Coupler Adapter (93410-1) to the base of the Loop Antenna Coupler, by the center screw of the adapter.

b) Insert the mast section of the antenna in the receptacle on the top of the coupler.

c) Install the three supporting arms into the holes in the mast section; aligning the slots at the ends of the arms in the plane of the loop.

d) Insert the coaxial cable (used to form the loop) in the slots in the arms, and connect the cable ends to the BNC receptacles on the top of the coupler.

NOTE

The cable is taut when properly installed on the support arms.

2.18 MOUNTING THE LOOP ANTENNA ON RFI METER

If the antenna is to be used on the RFI Meter, proceed as follows:

a) Mount the assembled antenna on the top of the RFI Meter by means of the screws on the adapter.

b) Mount the RFI Meter on the Tripod (91933-2) so that it may be rotated.

c) Loosen the center knob on the tripod and rotate the RFI Meter to the desired antenna orientation; tighten the center knob.

d) Connect one end of the two-foot RF Transmission Line (92191-2) to the OUTPUT receptacle on the Loop Antenna Coupler.

e) Connect the other end of the RF Transmission Line to the RF INPUT receptacle on the RFI Meter.

2.19 MOUNTING THE LOOP ANTENNA ON TRIPOD

If the antenna is to be located remotely from the RFI Meter, proceed as follows:

a) Mount the assembled antenna directly on the Tripod by adjusting the center screw.

b) The antenna can then be rotated to any desired position around the vertical axis of the tripod.

c) Connect one end of the 20-foot RF Transmission Line (92191-1) to the OUTPUT receptacle on the Loop Antenna Coupler.

d) Connect the other end of the RF Transmission Line to the RF INPUT receptacle on the RFI Meter.

2.20 LOOP PROBE

The Loop Probe (90799-3) is used to detect electromagnetic radiated leakage from shielded enclosures. The primary advantage of the probe is that it can be used in areas where limited accessibility prevents the use of other signal pickup devices. The probe provides relative indications only, rather than actual signal measurements. Therefore, calibration data is not provided. The Loop Probe is connected as follows:

a) Attach the Antenna Coupler Adapter (93410-1) to the base of the Loop Antenna Coupler, by the center of the adapter.

b) Mount the Loop Antenna Coupler on the top of the RFI Meter by means of the screws on the adapter.

c) Connect one end of the 20-foot RF Transmission Line (92191-1) to the output receptacle of the Loop Probe.

d) Connect the other end of the RF Transmission Line to the BNC receptacle (without the shorting cap) on the top of the Loop Antenna Coupler (92938-2). Install the shorting cap on the other BNC connector.

e) Connect one end of the 2-foot RF Transmission Line (92191-2) to the OUTPUT receptacle on the Loop Antenna Coupler.

f) Connect the other end of the RF Transmission Line to the RF INPUT receptacle on the RFI Meter.

2.21 ROD ANTENNAS

Both the 53-inch (92221-2) and 86-inch (92222-2) telescopic Rod Antennas must be attached to the Rod Antenna Coupler (92943-1), and extended to their maximum lengths during use. The coupler, in turn, is connected to the RF INPUT of the RFI Meter, and matches the high impedance of the Rod Antennas to the 50-ohm input impedance in each of the four bands.

2.22 MOUNTING THE ROD ANTENNA ON RFI METER

If the antenna is to be used on the RFI Meter, proceed as follows:

a) Attach the Antenna Coupler Adapter (93410-1) to the base of the Rod Antenna Coupler (92943-1), by the center screw of the adapter.

b) Attach the selected Rod Antenna to the insulated coaxial fitting on top of the Rod Antenna Coupler.

c) Mount the assembled antenna on the top of the RFI Meter by means of the screws on the adapter.

d) Mount the RFI Meter on the Tripod (91933-2).

e) Connect one end of the two-foot RF Transmission Line (92191-2) to the OUTPUT receptacle on the Rod Antenna Coupler.

f) Connect the other end of the RF Transmission Line to the RF INPUT receptacle on the RFI Meter.

2.23 MOUNTING THE ROD ANTENNA ON THE TRIPOD

If the antenna is to be located remotely from the RFI Meter, proceed as follows:

a) Perform Steps "a" and "b" of Paragraph 2.22.

b) Mount the assembled antenna on the Ground Plane (92199-3) by means of the screws on the adapter.

c) Mount the Ground Plane directly on the Tripod by adjusting the center knob.

d) Connect one end of the 20-foot RF Transmission Line (92191-1) to the OUTPUT receptacle on the Rod Antenna Coupler.

e) Connect the other end of the RF Transmission Line to the RF INPUT receptacle on the RFI Meter.

2.24 GROUND PLANE

The Ground Plane (2199-3) is not large enough to constitute a true signal ground. However, it may be enlarged by attaching a network of radial wires (or equivalent conductors) for greater accuracy in field intensity measurements. Provision is included for the attachment of up to 24 wires to the Ground Plane. The length of each radial wire must equal, or exceed, the height of the antenna.

NOTE

The Rod Antenna Factors (supplied in the Calibration Charts) are valid only when a true signal ground is used.

2.25 PREPARATION FOR CONDUCTED MEASUREMENTS

The NM-12AT RFI Meter and accessories may be connected for conducted measurements from 50-ohm, high impedance, or RF Current Probe input sources.

2.26 50-OHM INPUT

For conducted measurements from a 50-ohm input source, connect the equipment as follows:

a) Connect one end of the 20-foot RF Transmission Line (92191-1) to the RF INPUT receptacle on the RFI Meter.

b) Connect the other end of the RF Transmission Line to the 50-ohm signal source to be measured, using cable adapters as required (in cases where an impedance mismatch can be tolerated, the RF Transmission Line may be connected to higher or lower impedance signal sources).

CAUTION

Do not connect the RFI Meter input to signal sources exceeding 5 volts (AC or DC).

c) When directly measuring the harmonics (or spurious output) of a transmitter, first connect a tunable notch filter between the transmitter output and the RF Transmission Line: Carefully tune the filter to the transmitters fundamental frequency to obtain maximum rejection. Do this before connecting the RF Transmission Line to the RF INPUT receptacle. Observe the CAUTION following Step "b" above.

2.27 HIGH IMPEDANCE INPUT

For conducted measurements from a high impedance input source, connect the equipment as follows:

a) Connect one end of the 20-foot RF Transmission Line (92191-1) to the RF INPUT receptacle on the RFI Meter.

b) Connect the other end of the RF Transmission Line to the OUTPUT receptacle on the Rod Antenna Coupler (92943-1).

c) Attach the Impedance Matching Network (90081-4) to the Rod Antenna Coupler (use the N to BNC Adapter, 11663, if necessary).

CAUTION

The peak input voltage applied to the Impedance Matching Network must not exceed 500 volts DC, and the input power must not exceed 0.5 watts.

2.28 CURRENT PROBE INPUT

For conducted measurements from a RF Current Probe input source, connect the equipment as follows:

a) Connect one end of the 20-foot RF Transmission Line (92191-1) to the output receptacle of the RF Current Probe (use the N to BNC Adapter, 11663).

b) Connect the other end of the RF Transmission Line to the RF INPUT receptacle on the RFI Meter.

c) Open the probe and place it around the conductor, or cable group, to be tested: Be sure to center the conductor in the probe "window".

WARNING

If the conductor to be tested is not insulated, de-energize the conductor before attaching the RF Current Probe.

d) Lock the jaws of the probe by tightening the thumb screw (or other clamping means provided).

NOTE

Do not allow the RF Current Probe or cable connectors to make electrical contact with the ground plane, or nearby conductors. Also, do not place the probe near strong permanent magnets, or the field structures of motors or generators.

2.29 USE WITH RECORDERS

2.30 REQUIREMENTS

The NM-12AT RFI Meter may be used with a milliammeter recorder to provide continuous output plots of signal amplitude against time. The STODDART 91987-2 Graphic Milliammeter Recorder is specially designed for use with RFI Meters, however any suitable recorder can be used providing it has an input resistance of 1500 ohms, and a full-scale meter deflection of 1.0 milliampere.

2.31 RECORDING PAPER

Graph paper for the recorder can be calibrated in dB, or a correction rule, or scale, can be used to convert plots made on plain paper.

2.32 CONNECTION

To connect the STODDART 91987-2, Graphic Milliammeter Recorder, proceed as follows:

a) Attach the three-pin connector end of the six-foot Recorder Cable (90075-1) to the input receptacle of the recorder.

b) Plug the other end of the Recorder Cable into the Y-OUTPUT receptacle on the front panel of the RFI Meter.

c) Refer to the Recorder Instruction Manual for detailed operating instructions for the recorder.

2.33 USE WITH PLOTTERS

2.34 REQUIREMENTS

The NM-12AT RFI Meter may be used with an X-Y Plotter to provide an output plot of signal amplitude against frequency. Any suitable X-Y plotter can be used providing it has an X-input resistance of 100 kilohms or greater, and the Y-input resistance must be 1500 ohms. Both terminals of the "Y" output of the NM-12AT are above ground. Hence the plotter can not have one side of the "Y" input grounded.

NOTE

Most X-Y plotters have high X and Y input resistances. In this case, an external 1500-0hm resistance may be used to load the Y-input to the proper value (the 90075-4 "Y" Output Cable has this resistance internally supplied and connected).

2.35 CALIBRATION

The X output voltage from the RFI Meter is proportional to the indicated dial frequency throughout each band. The maximum X output voltage for any given band is 1.0 volt DC, and the maximum Y output voltage is 1.5 volts DC. The X and Y-pole sensitivities of the plotter must therefore be adjusted to these voltages. The X-axis scale of the plotter can then be calibrated in terms of frequency with the RFI Meter FREQUENCY dial, while the Y-axis can be calibrated with respect to the meter indication (approximately linear from 0 to 40 dB, or two decade, approximately logarithmic to 100 microvolts).

2.36 CONNECTION

To connect an X-Y plotter, proceed as follows:

a) Attach the spade-lug end of the Oscilloscope Cable (90071-1) to the X-input of the X-Y plotter.

NOTE

Make sure that the braid (ground) lead goes to the "low" side of the plotter X-input terminals.

b) Connect the other end of the Oscilloscope Cable to the X-OUTPUT (BNC) type) receptacle on the front panel of the RFI Meter.

c) Attach the three clip end of the 6-foot "Y" Output Cable (90075-4) to the Y-input of the X-Y plotter.

CAUTION

Make sure that the red insulated clip is connected to the positive input terminal and the black insulated clip is connected to the negative input terminal (do not ground either of these points). Connect the braid lead clip to the plotter chassis.

d) Plug the other end of the "Y" Output Cable into the Y-OUTPUT receptacle on the front panel of the RFI Meter.

e) Refer to the Plotter Instruction Manual for detailed operating instructions for the plotter.

2.37 USE WITH AUTO-PLOT CONTROLLER

2.38 GENERAL

The NM-12AT RFI Meter may be used in a system configuration with the STODDART Model APC-10 Auto-Plot Controller to provide automated RFI recordings of frequency vs. peak interference, or signal amplitudes. The APC-10 provides a mechanical drive to the RFI Meter to permit scanning through a single tuning band, and develops a frequency axis analog voltage. This is applied to the X-input of an associated X-Y plotter (STODDART Model 25, or other commercial X-Y plotter) to record the frequency scanned.

The RFI Meter IF output is applied to the APC-10, where the signals are amplified and peak detected, and applied to the Y-input of the plotter to record the peak signal amplitudes across the frequency scan.

2.39 SYSTEM CONFIGURATION

The APC-10 must be located close enough to the RFI Meter to permit interconnection of the 36-inch flexible drive cable between the 26 RPM motor output shaft and the RFI Meter TUNING shaft. Refer to the APC-10 Instruction Manual for detailed system interconnection instructions.

2.40 PRELIMINARY ADJUSTMENTS

2.41 ELECTRICAL ADJUSTMENTS

Every Model NM-12AT RFI Meter is carefully aligned and calibrated before leaving the factory. No further internal adjustments are necessary prior to operation.

2.42 PERIODIC OPERATING CHECKS

The following checks should be made periodically to verify that the instrument is operating properly:

a) Prepare the RFI Meter as described in Paragraphs 2-10 through 2-14.

b) Disconnect the AC Power Cable and set the POWER switch to the OFF position.

c) Check that the pointer on the front panel meter is exactly at mechanical zero: If not, adjust the screw on the front of the meter case to correct the error.

d) Set the POWER switch to the ON position and check that the BATTERY METER indicates in the white portion of the scale: If not, the battery must be recharged (Refer to Section III).

CAUTION

Do not operate the RFI Meter from a discharged battery, as this may damage the battery.

e) Disconnect the RF Transmission Line from the RF INPUT receptacle and set the ATTENUATOR to the +80 dB position.

f) Adjust the CAL control to the full-counter-clockwise position and check that the pointer on the front panel meter deflects to the left of mechanical zero.

g) Set the switch positions as follows:
   1) FUNCTION to CAL position
   2) BAND to BAND 1 position
   3) BANDWIDTH to BROAD position

h) Obtain the Band 1 broadband calibration figure from the Calibration Charts.

i) Standardize the RFI Meter gain for Band 1 by rotating the CAL control in a clockwise direction until the front panel meter indicates the calibration figure (in dB) from Step "h".

NOTE

The ATTENUATOR position has no effect on calibration.

j) Repeat Steps "g" through "i" for Bands 2, 3, and 4, respectively.

k) Connect a Rod or the Loop Antenna (Refer to Paragraphs 2.14 through 2.23), and plug the headset into the AUDIO receptacle.

l) Set the FUNCTION switch to the FI position and tune through each band. Adjust the ATTENUATOR as necessary to maintain an "on-scale" indication on

the panel meter, and the AUDIO control for a comfortable headset level. Listen for signals to verify that the RFI Meter is functioning properly on each band.

m) Tune the RFI Meter to any modulated RF signal and set the FUNCTION switch to the PEAK position.

n) Rotate the PEAK control fully clockwise. Check to see that the movable white bar of the PEAK motor moves all the way to the right (clockwise).

o) Slowly rotate the PEAK control counter-clockwise and check to see that the movable white bar starts to move to the left (counter-clockwise).

2.43 LOOP ANTENNA ORIENTATION AND SIGNAL BEARINGS

2.44 GENERAL

One of the most useful properties of the Collapsible Loop Antenna (92938-2) is that it may be used to obtain the approximate bearing of a signal source. However, before it can be used for this purpose, it must be oriented toward a magnetic North bearing.

2.45 ORIENTATION PROCEDURE

Orient the Loop Antenna as follows:

a) Prepare the RFI Meter as described in Paragraphs 2.10 through 2.14.

b) Assemble the Loop Antenna and mount it on the Tripod (91933-2), as described in Paragraphs 2.17 and 2.19.

c) Loosen the locknut on the Tripod platform, and verify that the Loop Antenna is free to rotate around a vertical axis on the Tripod head.

NOTE

Remove metal objects from pockets, and tools or magnets from the vicinity before reading the compass in the following step.

d) Orient the plane of the loop in a "North-South" direction using a magnetic compass.

NOTE

The readings on the azimuth scale directly in line with the loop frame are at 90 and 270 degrees, respectively. Mark these points on the rim of the Tripod head, and use the marks as a "North-South" reference line.

2.46 SIGNAL BEARINGS

The Loop Antenna responds to the magnetic component of a radiated signal. Maximum output from the loop is obtained when the plane of the loop is parallel to the direction in which the radiated wave is traveling. Minimum output is obtained when the plane of the loop is perpendicular to the direction of propagation.

a) FIELD INTENSITY MEASUREMENTS: For field Intensity measurements, the loop is rotated to obtain maximum signal strength as indicated by the RFI Meter.

b) DIRECTION FINDING: For direction finding, the loop is rotated to obtain a minimum, or null indication from the RFI Meter. When the null is obtained, the location of the radiating source is perpendicular to the plane of the loop.

2.47 TRANSPORTING THE EQUIPMENT

The RFI Meter and accessories should be stored in the Transit cases when the equipment is not in use. The Transit cases are intended for transportation of the equipment from one measurement location to another, but not for transport by common carrier. For this purpose, pack the Transit cases in the original shipping case.

SECTION III

OPERATING INSTRUCTIONS

3.1 GENERAL

3.2 This section covers operation of the STODDART Model NM-12AT RFI Meter, including a description of the operating controls and indicators, receptacles, instructions for using the various signal input devices, calibration (gain standardization), measurement procedures, and battery charging instructions.

3.3 CONTROLS, INDICATORS AND RECEPTACLES

3.4 OPERATING CONTROLS

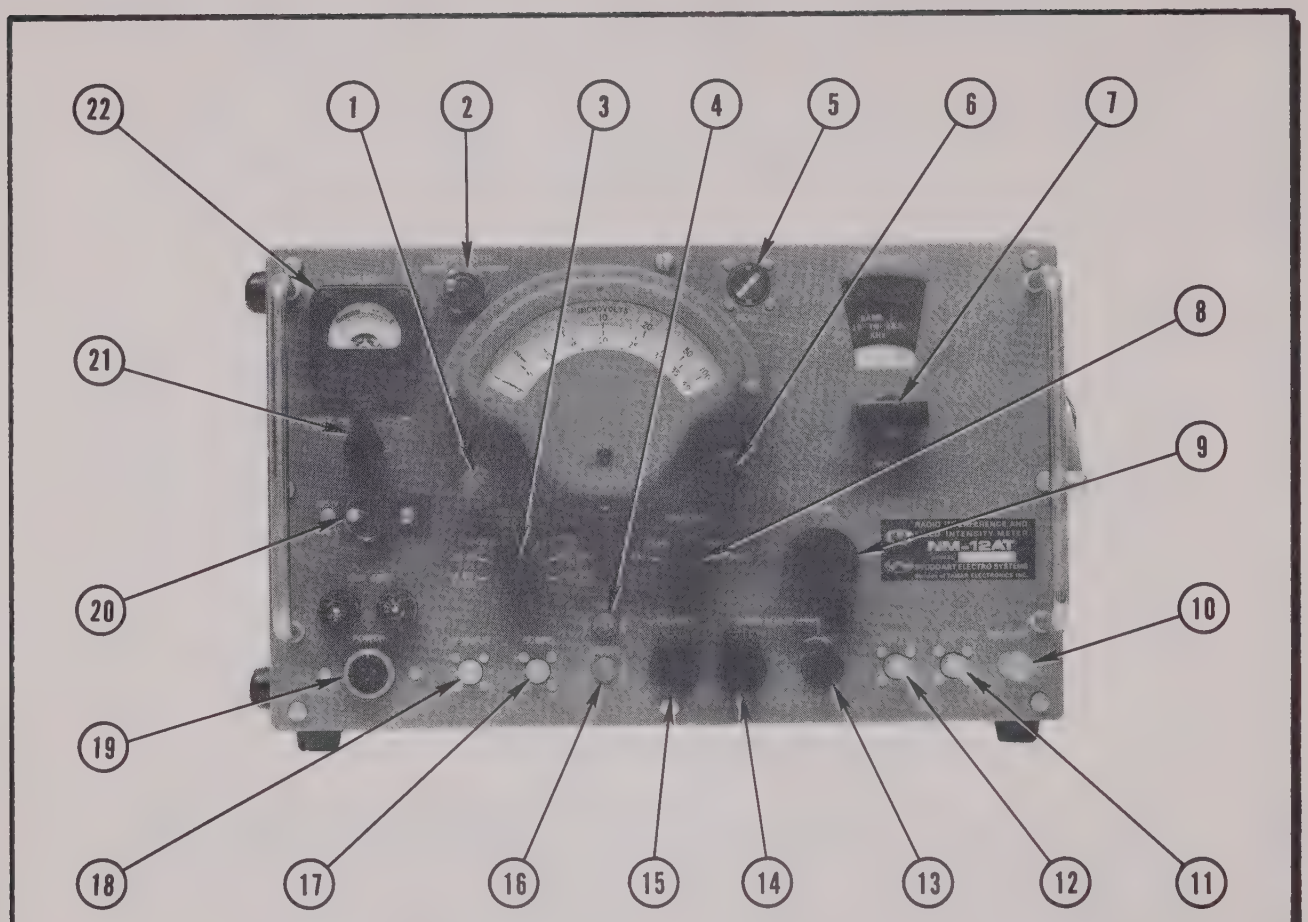
All operating controls are located on the front panel of the RFI Meter. These are illustrated in Figure 3-1, and tabulated in Table 3-1.

3.5 INDICATORS

All indicators are located on the front panel of the RFI Meter. These are illustrated in Figure 3-1, and tabulated in Table 3-2.

3.6 RECEPTACLES

All receptacles are located on the front panel of the RFI Meter. These are illustrated in Figure 3-1, and tabulated in Table 3-3.



KEY TO FIGURE 3-1

1. CAL Control	12. X-OUTPUT Receptacle
2. BAND WIDTH Switch	13. AUDIO Control
3. ATTENUATOR Switch	14. AUDIO Receptacle
4. AGC Switch	15. Y-OUTPUT Receptacle
5. PEAK Meter	16. METER Switch
6. PEAK Control	17. SCOPE Receptacle
7. BAND Selector	18. RF INPUT Receptacle
8. FUNCTION Switch	19. POWER Receptacle
9. TUNING Control	20. Voltage Selector Switch
10. GROUND Connection	21. POWER Switch
11. IF OUTPUT Receptacle	22. BATTERY Meter

Figure 3-1. STODDART NM-12AT RFI Meter, Operating Controls, Indicators, and Receptacles

Table 3-1. Operating Controls

CONTROL	REF. DESIG.	FUNCTION
ATTENUATOR Switch	S101	Seven-position rotary switch; selects total signal attenuation in steps, from -40 to +80 dB, as follows: -40 dB/X0.01: Does not attenuate RF or IF signal. Signal input is one-hundredth of meter reading in microvolts. -20 dB/X0.1: Does not attenuate RF signal, but does attenuate IF signal by 20 dB. 0 dB/X1: Attenuates both RF and IF signal levels by 20 dB. +20 dB/X10: Attenuates RF signal by 40 dB, and IF by 20 dB. +40 dB/X10^2: Attenuates RF signal by 60 dB, and IF by 20 dB. +60 dB/X10^3: Attenuates RF signal by 80 dB, and IF by 20 dB. +80 dB/X10^4: Attenuates RF signal by 100 dB, and IF by 20 dB.
FUNCTION Switch	S103	Five-position rotary switch; selects measurement function as follows: CAL: Disconnects RF input and energizes impulse generator to standardize gain. FI: Weights signal at detector output to permit measurement of average signal values. QP: Weights signal at detector output to permit measurement near the peak value of signal.

Table 3-1. Operating Controls (Continued)

CONTROL	REF. DESIG.	FUNCTION
FUNCTION Switch (Cont)		PEAK: Applies reverse bias to detector for slideback peak signal measurements. BFO: Energizes beat frequency oscillator to permit audible reception of CW signals.
BAND Switch	S401	Four-position rotary switch; selects tuned circuits for Bands 1 thru 4.
TUNING Control	----	Tunes the receiver within the selected band.
BAND WIDTH Switch	S110	Two-position toggle switch; selects overall receiver bandwidth as follows: NARROW: Inserts 100 Hz bandwidth crystal filter in IF preamplifier. BROAD: Removes crystal filter from IF preamplifier.
POWER Switch	S108	Three-position rotary switch, as follows: CHARGE:Actuates the battery charging circuit and charges the battery (RFI Meter inoperative) when connected to an AC power source. OFF: Removes power from the RFI Meter. ON: Applies power to the RFI Meter, and also charges the battery when connected to an AC power source.
105V-125V/210V-250V Switch	S302	Two-position toggle switch. Power line selector switch. A retaining plate holds the switch in the selected position, showing only the selected input voltage range.

Table 3-1. Operating Controls (Continued)

CONTROL	REF. DESIG.	FUNCTION
METER Switch	S105	Two-position toggle switch; selects response time of front panel meter, as follows: FAST: Provides normal meter response characteristics. SLOW: Lengthens meter response time.
AGC Switch	S109	Two-position toggle switch; provides ON and OFF facilities for AGC.
CAL Control	R168	Adjusts overall gain of RFI Meter during calibration.
AUDIO Control	R241	Adjusts level of audio output.
PEAK Control	R203	Adjusts reverse bias level applied to detector for peak signal measurements.

Table 3-2. Indicators

INDICATOR	REF. DESIG.	FUNCTION
Meter	M101	Four-inch scale length to indicate signal strength; calibrated in two-decade logarithmic from 1 to 100 microvolts, and approximately linear from 0 to 40 dB.
BATTERY Meter	M103	Expanded scale (12 to 17 volts) meter to indicate battery condition.
PEAK Meter	M102	Movable white bar meter to indicate peak "threshold".

Table 3-3. Receptacles

RECEPTACLE	REF. DESIG.	FUNCTION
POWER	J301	Three-pin AC power input receptacle.
RF INPUT	J101	BNC Coaxial receptacle; 50-ohm RF signal input.
SCOPE	J119	BNC coaxial receptacle; approximately 500 kilohms oscilloscope output impedance. Detector output for visual monitoring.
Y-OUTPUT	J121	Two-pole receptacle; 1500-ohm output impedance (one milliampere maximum) for remote meter or graphic recorder.
AUDIO	J118	Headset receptacle; 600-ohm impedance, for aural monitoring.
X-OUTPUT	J122	BNC coaxial receptacle; provides a DC voltage indicating TUNING dial frequency in each band.
IF OUTPUT	J120	BNC coaxial receptacle; 50-ohm output impedance; provides 455 kHz output signal from IF amplifier.
GROUND	----	Binding post; provides for connection of an external ground.

3.7 CALIBRATION

3.8 GENERAL

The Model NM-12AT RFI Meter must be calibrated (gain standardized) prior to making a measurement of signal level. This is done at the measurement frequency, and utilizes the internal impulse generator circuit. When properly calibrated, the RFI Meter indicates the signal level for narrowband measurements in microvolts, and for broadband measurements, the spectral intensities directly in microvolts/kHz. To accomplish this, different calibration figures are used for narrow and broadband measurements.

3.9 PROCEDURE

Calibrate the NM-12AT as follows:

a) Prepare the RFI Meter as described in Paragraphs 2-10 through 2-14 (Section II).

b) Set the POWER switch to the ON position.

c) Set the BAND switch to the proper frequency range, and adjust the TUNING Control to the desired frequency.

d) Set the FUNCTION switch to the CAL position.

e) If a narrowband (or CW type) signal is to be measured (or random interference), set the BAND WIDTH switch to the NARROW position and adjust the CAL control until the front panel meter indicates the dB value of the NB Cal Figure (Narrowband calibration figure) given in the Calibration Charts under section "Standardizing Gain".

NOTE

Once the equipment is calibrated as above, narrowband signal (CW) or random interference measurements may be made in either position of the BAND WIDTH switch.

f) If a broadband (or impulse type) signal is to be measured, set the BAND WIDTH switch to the BROAD position and adjust the CAL control until the front panel meter indicates the dB value of the BB Cal Figure (Broad Band calibration figure) given in the Calibration Charts under section "Standardizing Gain".

NOTE

It is advisable to measure broadband signals only in the BROAD position of the BAND WIDTH switch because of the better broadband sensitivity and bandpass shape factor for broadband signals.

3.10 EXAMPLE

Assume a narrowband input signal is to be measured at a frequency of 30 kHz, and proceed as follows:

a) Set the BAND switch to BAND 2 and the BAND WIDTH switch to the NARROW position.

b) Adjust the TUNING control until the FREQUENCY dial indicates 30 kHz.

c) Set the FUNCTION switch to the CAL position and refer to the Calibration Charts to obtain the NB Cal Figure for BAND 2.

d) Assume the Calibration Chart indicates a calibration figure of 19.5 dB; then adjust the CAL control until the panel meter indicates 19.5 dB.

3.11 MEASUREMENT CATEGORIES

The types of signals measured with the NM-12AT fall into two general categories; i.e., narrowband and broadband. Each of these categories can again be subdivided into conducted or radiated measurements. Similarly, within each of these subdivisions different types of measurements can be performed, depending upon the input device employed. These are tabulated for reference in Table 3-4.

3.12 MEASUREMENT PROCEDURES

a) MEASUREMENT OF UNMODULATED CW SIGNALS: An unmodulated CW type signal will provide the same meter indication in either position of the BAND WIDTH switch. However, it is recommended that the BROAD position be used for signal "search", and the measurement then conducted in the NARROW position to obtain better sensitivity and a more accurate frequency reading. Calibration must be accomplished in the NARROW position (refer to Paragraph 3-9, step "e"). Also, when searching for an unmodulated CW signal in the BFO mode, the BAND WIDTH switch should be set to the BROAD position for the best aural response.

b) MEASUREMENT OF MODULATED CW SIGNALS: Modulated CW signals should be measured in the BROAD position of the BAND WIDTH switch. This is necessary to permit the modulation components to pass through the IF amplifier. However, as in the case of an unmodulated CW signal, the RFI Meter must be calibrated in the NARROW position.

c) MEASUREMENT OF BROADBAND SIGNALS: Random, or impulse type signals should always be measured in the BROAD position of the BAND WIDTH switch. The wider bandwidth provides much better sensitivity to broadband signals and also better bandpass shape factor for broadband signals.

d) BANDWIDTH SELECTION: The proper band width switch position for the calibration and measurement of various type signals may be determined from Table 3-5.

Table 3-4. Measurement Categories

CATEGORY AND SUBDIVISION	TYPE OF MEASUREMENT (INPUT DEVICE)	MEASUREMENT TERMS	PARA. REF.
Narrowband (modulated or unmodulated RF carrier):			
Conducted:	50-ohm; high impedance; LISN	Microvolts, or dB above one microvolts	3-21 3-22
	RF Current Probe	Microamperes, or dB above one microampere	3-23
Radiated:	Rod or Loop Antenna	Microvolts/meter, or dB above one microvolt/meter	3-24
	Antenna induced, or open circuit antenna (rod antenna only	Microvolts, or dB above one microvolt	3-24

Table 3-4. Measurement Categories (Continued)

CATEGORY AND SUBDIVISION	TYPE OF MEASUREMENT (INPUT DEVICE)	MEASUREMENT TERMS	PARA. REF.
Broadband (where signal is much wider than bandwidth of the RFI Meter):			
Conducted:	50-ohm; high impedance; LISN	1) Microvolts/kHz, or dB above one microvolt/kHz	3-31, 3-32
		2) Microvolts/MHz, or dB above one microvolt/MHz	3-31, 3-32, 3-29
	RF Current Probe	1) Microamperes/kHz, or dB above one microampere/kHz	3-33
		2) Microamperes/MHz, or dB above one microampere/MHz	3-33, 3-29
Radiated:	Rod or Loop Antenna	1) Microvolts/meter/kHz, or dB above one microvolt/meter/kHz	3-34
		2) Microvolts/meter/MHz, or dB above one microvolt/meter/MHz	3-34 3-29
	Antenna induced, or open circuit antenna (rod antenna only).	1) Microvolts/kHz, or dB above one microvolt/kHz	3-34
		2) Microvolts/MHz, or dB above one microvolt/MHz	3-34, 3-29

Table 3-5. Bandwidth Selection

TYPE OF SIGNAL	BANDWIDTH SWITCH POSITION	
	CALIBRATION	MEASUREMENT
Unmodulated CW	NARROW	NARROW
Modulated CW	NARROW	BROAD
Random	NARROW	BROAD
Impulse	BROAD	BROAD
Broadband	BROAD	BROAD

NOTE

Most Military and Government Specifications on EMI treat random interference and impulse interference as the same, and categorize them together as BROADBAND interference.

3.13 MEASUREMENT FUNCTIONS

Signals may be measured in terms of average, weighted (quasi-peak), or peak values. The particular measurement function employed depends upon the application of the equipment, and the nature of the signal. An unmodulated RF carrier will provide identical meter readings when measured in the FI, QP, or PEAK detector functions. However, when measuring a modulated RF carrier (or interference), the proper detector function must be selected for the type of modulation encountered, as follows:

a) AVERAGE (FI) VALUE: Average value measurements of RF signals are in terms of the RMS value of the average signal level. The presence of symmetrical amplitude modulation (from zero to 100-percent) will not affect the results.

b) WEIGHTED (QP) VALUE: Weighted values are used to measure near the peak value of RF signals having a relatively fast repetition frequency. When measuring RF carriers that are amplitude modulated by speech, the QP and PEAK detector functions provide nearly identical meter readings. The ratio of the QP and FI readings therefore can be used to determine the percentage of modulation. The QP detector is convenient to use when searching for a signal as it has a fast response time, enabling faster scanning than for FI or manual slideback PEAK.

c) PEAK VALUE: Peak value measurements are preferred when the modulation on an RF carrier consists of sharp pulses at a low repetition rate, as meter readings in the QP function will decrease under these conditions. Peak value measurements in turn may be made using either of two methods; i.e., visual, or aural null indication.

3.14 AVERAGE VALUE MEASUREMENT PROCEDURE: Perform average value measurements as follows:

a) Standardize the RFI Meter gain at the measurement frequency, as described in paragraph 3-9, steps "a" through "e", for Narrow Band Calibration.

b) Set the FUNCTION switch to the FI position and adjust the ATTENUATOR for an "on-scale" meter indication.

NOTE

Slowly "rock" the TUNING control back and forth to peak the meter indication.

c) Readjust the ATTENUATOR if necessary, to keep the meter indication in the upper portion of the scale; record the ATTENUATOR setting and meter indication (in microvolts or dB).

3.15 WEIGHTED VALUE MEASUREMENT PROCEDURE

Perform weighted value measurements as follows:

a) Standardize the RFI Meter gain at the measurement frequency, as described in Paragraph 3-9, steps "a" through "e", for NARROW Band calibration.

b) Set the FUNCTION switch to the QP position and adjust the ATTENUATOR for an "on-scale" meter indication.

NOTE

Slowly "rock" the TUNING control back and forth to peak the meter indication.

c) Readjust the ATTENUATOR as necessary, to keep the meter indication in the upper portion of the scale; record the ATTENUATOR setting and meter indication (in microvolts or dB).

3.16 VISUAL NULL PEAK VALUE MEASUREMENT PROCEDURE

Perform the visual null peak value measurements as follows:

a) Standardize the RFI Meter gain at the measurement frequency, as described in Paragraph 3-9. This can be done for either narrow or broad band, depending upon the type of signal to be measured.

b) Set the FUNCTION switch to the PEAK position.

c) Rotate the PEAK control counter-clockwise until the white bar of the PEAK indicator moves to the counter-clockwise position.

d) Then rotate the PEAK control clockwise and adjust the ATTENUATOR so the white bar of the PEAK indicator moves in a clockwise direction when the output meter registers in the upper portion of its scale.

e) Slowly adjust the PEAK control counter-clockwise until the white bar of the PEAK indicator is vertical.

f) Record the ATTENUATOR setting and meter indication (in microvolts or dB) at the threshold point.

NOTE

The NM-12AT is calibrated in terms of RMS sinusoidal values (the value used in most EMI specifications, although FED-STD-222 is one exception, using true peak values). To find the true peak value of a signal when using the PEAK function, either multiply the meter reading in microvolts by 1.41, or add 3 dB if the meter reading is in dB.

3.17 AURAL NULL PEAK VALUE MEASUREMENT PROCEDURE

Perform aural null peak value measurements as follows:

a) Standardize the RFI Meter gain at the measurement frequency, as described in Paragraph 3-9. This can be done for either narrow or broad band, depending upon the type of signal to be measured.

b) Set the FUNCTION switch to the PEAK positions.

CAUTION

In the PEAK function, the AUDIO gain control is inoperative. The audio gain is fixed at a high level for better determination of the signal threshold point. Use headphones with caution on strong signals.

c) Connect a headset to the AUDIO receptacle. Rotate the PEAK control counter-clockwise until the signal is heard in the headphones; adjust the ATTENUATOR as necessary.

d) Rotate the PEAK control clockwise and adjust the ATTENUATOR so the signal becomes inaudible in the headset when the output meter registers in the upper portion of its scale.

e) Slowly adjust the PEAK control counter-clockwise until the signal crosses the threshold and becomes barely audible.

f) Record the ATTENUATOR setting and meter indication (in microvolts or dB) at the threshold point.

3.18 MEASURING NARROWBAND SIGNALS

3.19 Narrowband signals may consist of a modulated or unmodulated RF carrier. The particular detector function employed in their measurement will therefore be determined by the characteristics of the modulation present (if any) on the carrier (Refer to Paragraph 3-13). Narrowband measurements can be separated into two basic groups; i.e., conducted and radiated. These can be further subdivided as to the type of measurement performed within each group (input device employed, etc.), and to the form in which the results are expressed (microvolts, dB, etc.).

3.20 CONVERSION OF UNITS

Signal levels in terms of dB above one microvolt may be converted directly into microvolts (or millivolts), and vice-versa by referring to the Conversion Table, Table 3-6. The Conversion Table covers a range of -40 dB (0.01 microvolt) to +120 dB (1.0 volt), in steps of 1.0 dB.

3.21 50-OHM CONDUCTED NARROWBAND MEASUREMENTS

When the RFI Meter is used as a two-terminal RF voltmeter across 50 ohms, signal levels may be computed either in terms of microvolts, or in dB above one microvolt, as follows:

NOTE

Refer to Section II (Paragraph 2-26) for specific instructions and general precautions.

a) MEASUREMENTS IN MICROVOLTS: Multiply the meter reading in microvolts by the ATTENUATOR setting (X0.01 to $X10^4$).

EXAMPLE: With a meter reading of 20 microvolts an ATTENUATOR setting of $X10^2$, the signal level is 20 x 100 = 2000 microvolts.

b) MEASUREMENTS IN DB ABOVE ONE MICROVOLT: Add the meter reading in dB to the ATTENUATOR setting in dB

EXAMPLE: With a meter reading of 26 dB and an ATTENUATOR setting of +40 dB, the signal level is 26 + 40 = 66 dB above one microvolt.

CONVERSION TABLE 3-6

dB Above 1 uV	uV	dB Above 1 uV	uV
-40	0.01	-5	0.562
-39	0.0112	-4	0.631
-38	0.0126	-3	0.708
-37	0.0141	-2	0.794
-36	0.0159	-1	0.891
-35	0.0178	0	1.00
-34	0.0200	1	1.12
-33	0.0224	2	1.26
-32	0.0251	3	1.41
-31	0.0282	4	1.59
-30	0.0316	5	1.78
-29	0.0355	6	2.00
-28	0.0398	7	2.24
-27	0.0447	8	2.51
-26	0.0501	99	2.82
-25	0.0562	10	3.16
-24	0.0631	11	3.55
-23	0.0708	12	3.98
-22	0.0794	13	4.47
-21	0.0890	14	5.01

CONVERSION TABLE 3-6 (Continued)

dB Above 1 uV	uV	dB Above 1 uV	uV
-20	0.100	15	5.62
-19	0.112	16	6.31
-18	0.126	17	7.08
-17	0.141	18	7.94
-16	0.159	19	8.91
-15	0.178	20	10.00
-14	0.200	21	11.20
-13	0.224	22	12.60
-12	0.251	23	14.30
-11	0.282	24	15.90
-10	0.316	25	17.80
- 9	0.355	26	20.00
- 8	0.398	27	22.40
- 7	0.447	28	25.10
- 6	0.501	29	28.20
30	31.60	63	1.41
31	35.50	64	1.59
32	39.80	65	1.78
33	44.70		
34	50.10	66	2.00
		67	2.24
35	56.20	68	2.51
36	63.10	69	2.82
37	70.80	70	3.16
38	79.40		
39	89.10	71	3.55
		72	3.98
40	100.00	73	4.47
		74	5.01
		75	5.62

dB Above 1 uV	mV		
41	0.112	76	6.31
42	0.126	77	7.08
43	0.141	78	7.94
44	0.159	79	8.91
45	0.178	80	10.00
46	0.200	81	11.20
47	0.224	82	12.60
48	0.251	83	14.10
49	0.282	84	15.90
50	0.316	85	17.80

CONVERSION TABLES 3-6 (Continued)

dB Above 1 uV	mV	dB Above 1 uV	uV
51	0.355	86	20.00
52	0.398	87	22.40
53	0.447	88	25.10
54	0.501	89	28.20
55	0.562	90	31.60
56	0.631	91	35.50
57	0.708	92	39.80
58	0.794	93	44.70
59	0.891	94	50.10
60	1.000	95	56.20
61	1.12	96	63.10
62	1.26	97	70.80

			Volts
98	79.80	108	0.251
99	89.10	109	0.282
100	100.00	110	0.316
		111	0.355
dB Above 1 uV	Volts	112	0.398
		113	0.447
101	0.112	114	0.501
102	0.126	115	0.562
103	0.141		
104	0.159	116	0.631
105	0.178	117	0.708
		118	0.794
106	0.200	119	0.891
107	0.224	120	1.000

3.22 HIGH IMPEDANCE CONDUCTED NARROWBAND MEASUREMENTS

The RFI Meter, in conjunction with the Rod Antenna Coupler (92943-1) and Impedance Matching Network (90081-4), may be used as a two-terminal high impedance RF voltmeter. Signal levels may be computed either in terms of microvolts, or in dB above one microvolt, as follows:

NOTE

Refer to Section II (Paragraph 2-27) for specific instructions and general precautions.

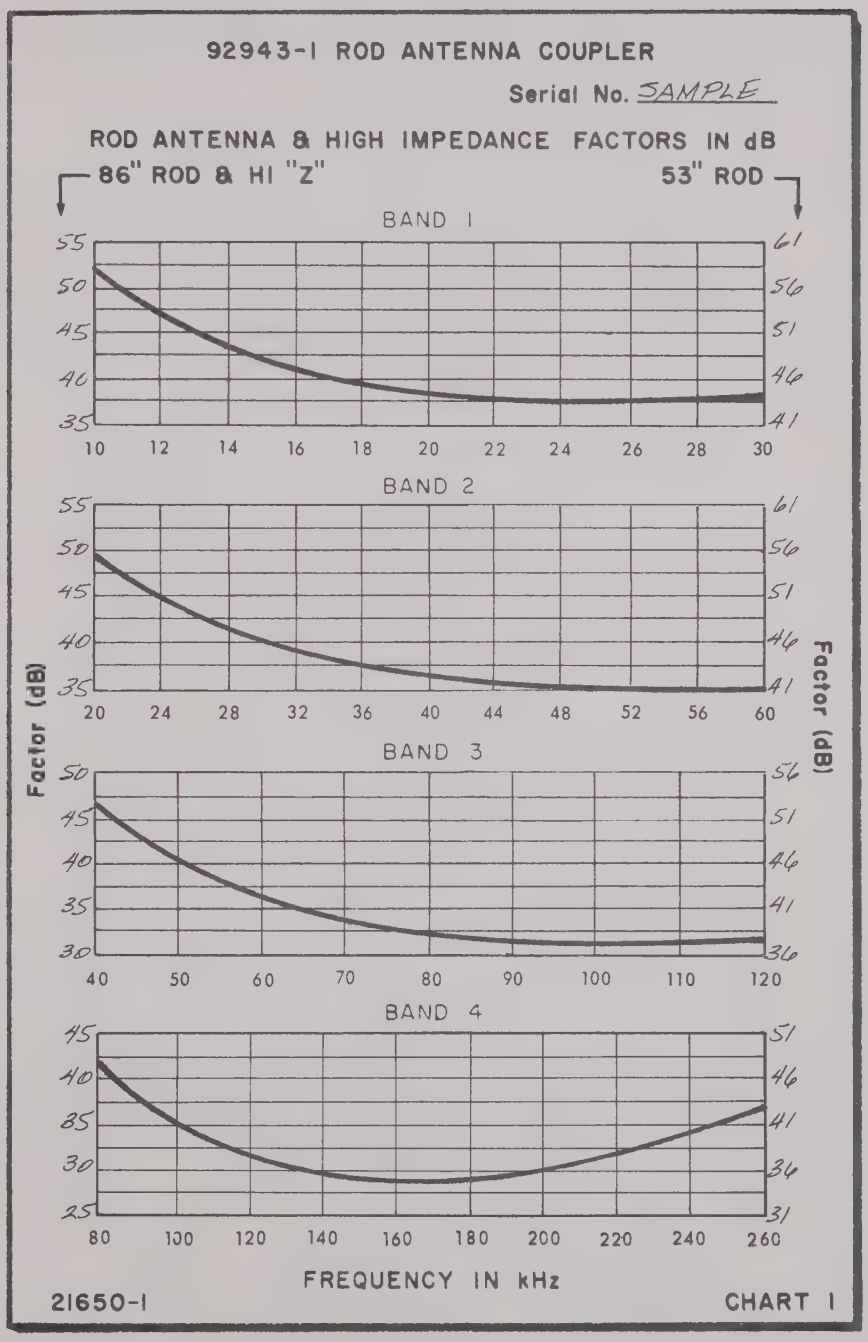


Figure 3-2. Typical Rod Antenna and High Impedance Factors

a) MEASUREMENTS IN DB ABOVE ONE MICROVOLT: Add the meter reading in dB, the ATTENUATOR setting in dB, and the "high impedance factor" (in dB) from Chart 1 in the Calibration Charts (Refer to Figure 3-2 for a typical chart).

EXAMPLE: A meter reading of 26 dB is obtained for a 60 kHz conducted signal at an ATTENUATOR setting of +40 dB. The "high impedance factor" (from Chart 1) is 37 dB. The signal level then is 26 + 40 + 37 = 103 dB above one microvolt.

b) MEASUREMENTS IN MICROVOLTS:

1. Use the measurement procedure of sub-paragraph "a" above.
2. Convert the result in dB above one microvolt to microvolts using Table 3-6.

EXAMPLE: 103 dB above one microvolt (from the preceeding example) equals 0.141 volt (Table 3-6).

3.23 RF CURRENT PROBE CONDUCTED NARROWBAND MEASUREMENT

The RF Current Probe is a broadband transformer, and is used to measure RF currents in a cable, or conductor, without physically disturbing the circuit. Signal levels may be computed either in terms of microamperes, or in dB above one microampere, as follows:

NOTE

Refer to Section II (paragraph 2-28) for specific instructions and general precautions.

a) MEASUREMENTS IN MICROAMPERES: Multiply the meter reading in microvolts by the ATTENUATOR setting (X0.01 to $X10^4$), and divide the result by the current probe "transfer impedance" (in ohms) at the test frequency (Refer to the Current Probe Instruction Manual).

EXAMPLE: A meter reading of 15 microvolts is obtained for a 155 kHz conducted signal at an ATTENUATOR setting of X10. The "transfer impedance" (from Current Probe Instruction Manual) is 0.39 ohms. The corrected level then is (15 x 10) / 0.39 = 384 microamperes in the test sample lead.

b) MEASUREMENTS IN DB ABOVE ONE MICROAMPERE: Add the meter reading in dB to the ATTENUATOR setting in dB, and subtract the current probe "transfer impedance" in dB above one ohm (Refer to the Current Probe Instruction Manual).

EXAMPLE: A meter reading of 23.5 dB is obtained for a 155 kHz conducted signal at an ATTENUATOR setting of +20 dB. The "transfer impedance" (from Current Probe Instruction Manual) is -8.2 dB below one ohm. The corrected level then is (23.5 + 20 dB -(8.2 dB) = 51.7 dB above one microampere in the test sample lead.

3.24 RADIATED NARROWBAND SIGNAL MEASUREMENTS

When a Rod (92221-2 or 92222-2) or Loop (92938-2) Antenna is used, signal levels may be computed either in terms of microvolts/meter, or in dB above one microvolt/meter. In addition, with a rod antenna the "antenna induced" voltage (or open circuit antenna) may be computed either in terms of microvolts, or in dB above one microvolt. These computations are carried out as follows:

a) MEASUREMENTS IN DB ABOVE ONE MICROVOLT/METER: Add the meter reading in dB, the ATTENUATOR setting in dB, and the appropriate "antenna correction factor" in dB from Chart 1 or 2 in the Calibration Charts (Refer to Figures 3-2 and 3-3 for typical charts).

NOTE

Chart 1 (Figure 3-2) is used for measurements with the 92221-2 and 92222-2 Rod Antennas, while Chart 2 (Figure 3-3) is used for measurements with the 92938-2 Loop Antenna.

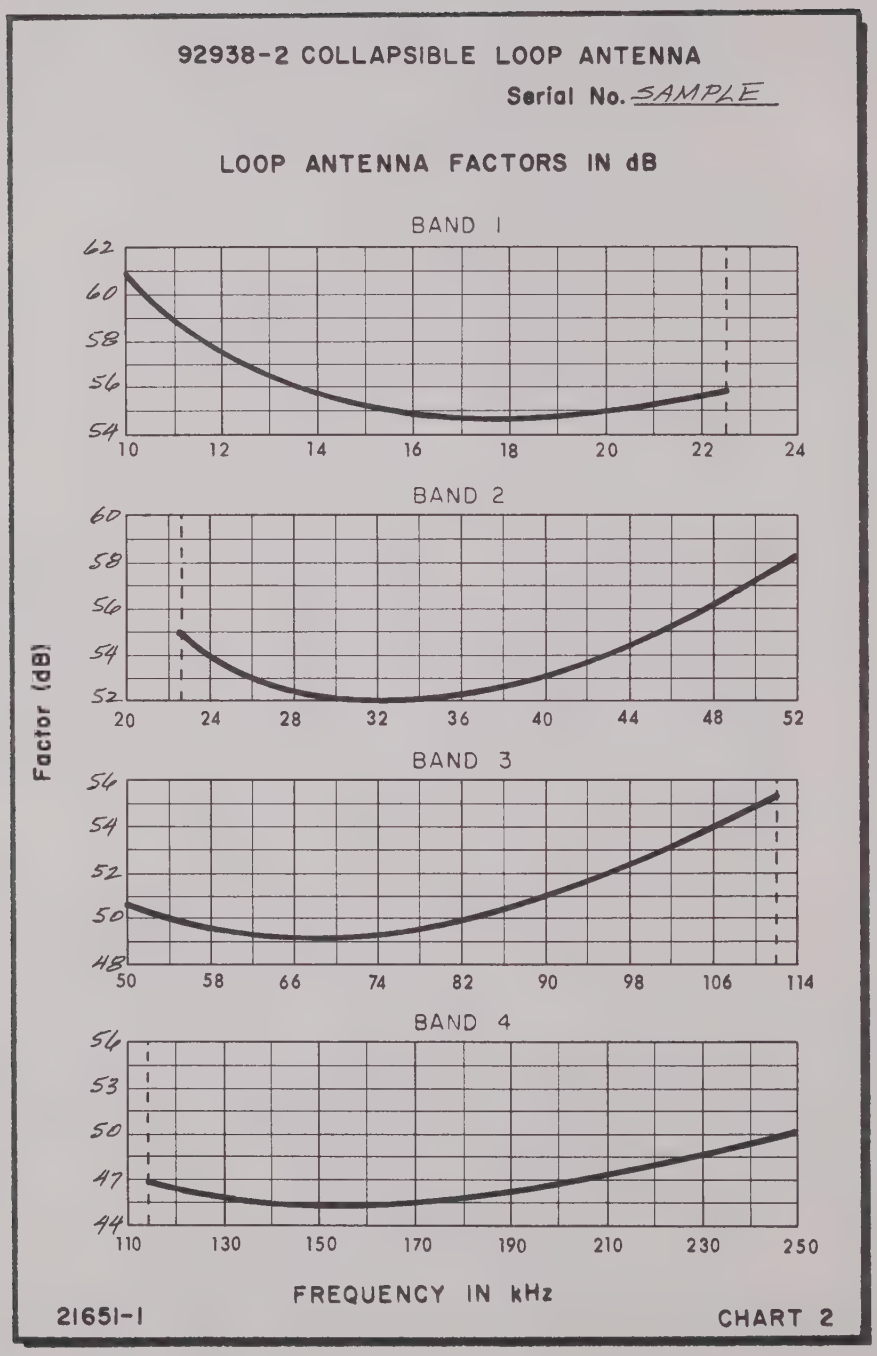


Figure 3-3. Typical Loop Antenna Factors

EXAMPLE: With the one-meter (86-inch) Rod Antenna as the signal pickup device, a meter reading of 26 dB is obtained for a 60 kHz signal at an ATTENUATOR setting of +40 dB. The "antenna correction factor" (from Chart 1) is 37 dB. The signal level then is 26 + 40 + 37 = 103 dB above one microvolt/meter. Note that the "antenna correction factor" would be 43 dB (6 dB higher) if the 53 " Rod were used.

b) MEASUREMENTS IN MICROVOLTS/METER:

1. Use the measurement procedure of sub-paragraph "a" above.
2. Convert the result in dB above one microvolt/meter to microvolts/meter using Table 3-6.

EXAMPLE: 103 dB above one microvolt/meter (from the preceeding example) equals 0.141 volt/meter (Table 3-6).

c) MEASUREMENTS IN DB ABOVE ONE MICROVOLT ANTENNA INDUCED: Add the meter reading in dB, the ATTENUATOR setting in dB, and the "high impedance factor" (in dB) from Chart 1 in the Calibration Charts (Refer to Figure 3-2 for a typical chart).

EXAMPLE: With a one-meter (86-inch) Rod Antenna as the signal pickup device, a meter reading of 26 dB is obtained for a 60 kHz signal at an ATTENUATOR setting of +40 dB. The "high impedance factor" (from Chart 1) is 37 dB. The signal level then is 26 + 40 + 37 = 103 dB above one microvolt antenna induced. Note that the same "High Impedance Factor" in dB would be used for the 53" rod for "antenna induced" measurements.

d) MEASUREMENTS IN MICROVOLTS ANTENNA INDUCED:

1. Use the measurement procedure of sub-paragraph "c" above.
2. Convert the result in dB above one microvolt using Table 3-6.

EXAMPLE: 103 dB above one microvolt (from the preceding example) equals 0.141 volt antenna induced (Table 3-6).

3.25 MEASURING SINUSOIDAL RF SIGNALS IN THE PRESENCE OF HIGH LEVEL INTERFERENCE

Sine wave RF signals must often be measured in the presence of high level random interference. In these cases, the interference can be compensated for, and the amplitude of the RF signal can be estimated with resonable accuracy. The signal levels may be computed either in terms of microvolts, or in dB above one microvolt, as follows:

a) MEASUREMENTS IN MICROVOLTS:

1. Multiply the meter reading in microvolts by the ATTENUATOR setting to obtain the combined signal and "noise" measurement in microvolts.
2. Detune the RFI Meter slightly off the signal (or remove signal) and measure the "noise" alone. Multiply the meter reading in microvolts by the ATTENUATOR setting to obtain the "noise" measurement in microvolts.
3. Refer to Figure 3-4, and locate the result of step "1" ("noise-plus-signal") on the horizontal (MICROVOLTS) scale.

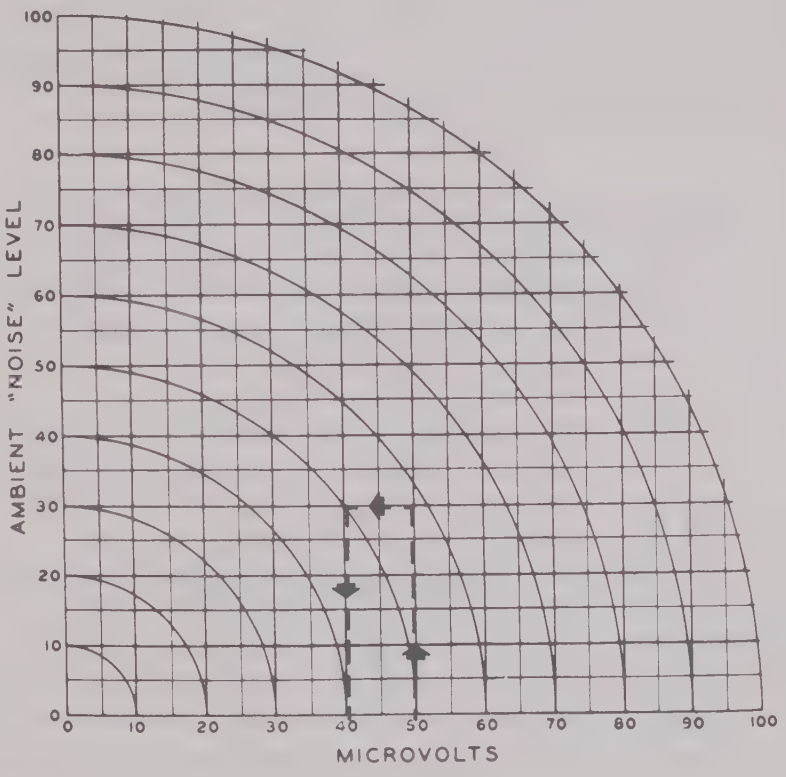


Figure 3-4. Correction Chart for Sine Wave Signals in the Presence of High Level Random Interference

4. Follow the arc upward until it intersects the horizontal line representing the "noise only" level obtained in step "2".

5. Drop down from the point of intersection to the horizontal scale and obtain the corrected meter reading (value of sine wave signal in the absence of "noise")

EXAMPLE: With a "noise-plus-signal" meter reading of 50 microvolts and a "noise only" reading of 30 microvolts (ATTENUATOR setting of X1 in both cases), the corrected signal level from Figure 3-4 is 40 microvolts.

b) MEASUREMENTS IN DB ABOVE ONE MICROVOLT:

1. Perform steps "1" through "5" of sub-paragraph "a" above.

2. Convert the result of step "5" to dB above one microvolt using Table 3-6.

EXAMPLE: 40 microvolts (from the preceding example) equals 32 dB above one microvolt (Table 3-6).

3.26 MEASURING BROADBAND SIGNALS

3.27 Broadband signals may consist of impulse or random type interference, or a combination of both types of signals. This is characterized as a signal that covers a very much wider range than the bandwidth of the test instrument, and may be defined as follows:

a) IMPULSE INTERFERENCE: Most Military and Government Interference Specifications consider impulse and random

interference to be the same, and group both under a term called Broadband Interference. Broadband interference can be defined as one or more electrical disturbances having a duration in seconds that is short with respect to the reciprocal of the RFI Meter bandwidth (expressed in Hz). If a series of impulses are considered, it is assumed that the interval between the impulses is such that one has died out before the next one starts; i.e., no overlapping. Broadband interference is measured with the PEAK detector function.

b) RANDOM INTERFERENCE: When dealing with strictly random type interference, independent of Military Specifications, special measurement techniques may be employed when accurate data processing is required (such as correlating data obtained from different bandwidth receivers). Random interference can be defined as overlapping pulses that are both random in spacing and amplitude. Typical sources of random interference are cosmic noise, corona discharges, shot noise from vacuum tubes, and ionized gas discharges. Because of the very nature of its varying amplitude characteristics, random interference is difficult to measure using the PEAK detector function. For this reason, the QP and FI detector functions are preferred. Refer to Paragraph 3-35 for a special treatment of this problem.

3.28 BROADBAND MEASUREMENT TERMS

Broadband measurement terms differ from the narrowband terms as the RFI Meter bandwidth now becomes part of the equation (Refer to Table 3-4). This is defined as follows:

a) CONDUCTED SIGNALS: Microvolts/kHz (or dB above one microvolt/kHz) and microamperes/kHz (or dB above one microampere/kHz).

b) RADIATED SIGNALS:

1. Rod or Loop Antenna; microvolts/meter/kHz (or dB above one microvolt/meter/kHz).

2. Antenna Induced (Rod Antenna only); Microvolts/kHz (or dB above one microvolt/kHz)

3. Magnetic field terms (for Loop Antenna only): Tesla, Gauss, Oersted, and Ampere-Turns per Meter per MHz.

3.29 CONVERSION OF TERMS

a) MEASUREMENTS IN MICROVOLTS:

1. To convert microvolts/kHz to microvolts/MHz, multiply by 1000.

2. To convert microvolts/MHz to microvolts/kHz, divide by 1000.

b) MEASUREMENTS IN DB ABOVE ONE MICROVOLT:

1. To convert dB above one microvolt/kHz to dB above one microvolt/MHz, add 60 dB.

2. To convert dB above one microvolt/MHz to dB above one microvolt/kHz, subtract 60 dB.

3.30 BANDWIDTH DATA

The narrowband 6 dB bandwidth and broadband impulse bandwidth for each individual instrument is given in the Calibration Charts. The random noise bandwidth may be obtained by multiplying the broadband impulse bandwidth by a factor of 0.7.

3.31 50-OHM CONDUCTED BROADBAND MEASUREMENTS

When the RFI Meter is used as a two-terminal RF voltmeter across 50 ohms and calibrated using the BB Cal Figures, as described in Paragraph 3-9, step "f", broadband interference levels may be computed either in terms of microvolts/kHz, or in dB above one microvolt/kHz, as follows:

a) MEASUREMENTS IN MICROVOLTS/kHz: Multiply the meter reading in microvolts by the ATTENUATOR setting to obtain a measurement directly in terms of microvolts/kHz.

EXAMPLE: With a meter reading of 20 microvolts and an ATTENUATOR setting of $X10^2$, the broadband interference level is 20 x 100 = 2000 microvolts/kHz.

b) MEASUREMENTS IN DB ABOVE ONE MICROVOLT/kHz: Add the meter reading in dB to the ATTENUATOR setting in dB.

EXAMPLE: With a meter reading of 25 dB and an ATTENUATOR setting of -40 dB, the broadband interference level is 25 + (-40) = -15 dB above one microvolt/kHz.

3.32 HIGH IMPEDANCE CONDUCTED BROADBAND MEASUREMENTS

The RFI Meter, in conjunction with the Rod Antenna Coupler (92943-1) and Impedance Matching Network (90081-4), may be used as a two-terminal high impedance RF voltmeter. Calibrate the RFI Meter using the BB Cal Figures as described in Paragraph 3-9, step "f". The impulse interference levels may be measured directly in terms of microvolts/kHz, or in dB above one microvolt/kHz, as follows:

NOTE

Refer to Section II (Paragraph 2-27) for specific instructions and general precautions.

a) MEASUREMENTS IN DB ABOVE ONE MICROVOLT/kHz: Add the meter reading in dB, the ATTENUATOR setting in dB, and the "high impedance factor" (in dB) from Chart 1 in the calibration charts (Refer to Figure 3-2 for a typical chart).

EXAMPLE: A meter reading of 26 dB is obtained for a 60 kHz conducted signal at an ATTENUATOR setting of +40 dB. The "high impedance factor" (from Chart 1) is 37 dB. The level is 26 + 40 + 37 = 103 dB above one microvolt/kHz.

b) MEASUREMENTS IN MICROVOLTS/kHz:

1. Use the measurement procedure of sub-paragraph "a" above.
2. Convert the result in dB above one microvolt/kHz to microvolts/kHz using Table 3-6.

EXAMPLE: 103 dB above one microvolt/kHz (from the preceding example) equals 141,000 microvolts/kHz.

3.33 RF CURRENT PROBE CONDUCTED BROADBAND MEASUREMENTS

The RF Current Probe is a broadband transformer, and is used to measure RF currents in cable, or conductor, without physically disturbing the circuit. Calibrate the RFI Meter using the BB Cal Figures as described in Paragraph 3-9, step "f". Impulse interference levels may be measured directly either in terms of microamperes/kHz, or in dB above one microampere/kHz, as follows:

NOTE

Refer to Section II (Paragraph 2-28) for specific instructions and general precautions.

a) MEASUREMENTS IN MICROAMPERES/kHz: Multiply the meter reading in microvolts by the ATTENUATOR setting (X0.01 to $X10^4$), and divide the result by the current probe "transfer impedance" (in ohms) at the test frequency (Refer to the Current Probe Instruction Manual).

EXAMPLE: A meter reading of 40 microvolts is obtained for a 155 kHz conducted signal at an ATTENUATOR setting of X0.1. The "transfer impedance" (from Current Probe Instruction Manual) is 0.39 ohms. The corrected level then is (40 x 0.1)/0.39 = 10.25 microamperes/kHz in the test sample lead.

b) MEASUREMENTS IN DB ABOVE ONE MICROAMPERE/kHz: Add the meter reading in dB to the ATTENUATOR setting in dB, and subtract the current probe "transfer impedance" in dB above one ohm (Refer to the Current Probe Instruction Manual).

EXAMPLE: A meter reading of 15 dB is obtained for a 155 kHz conducted signal at an ATTENUATOR setting of -20 dB. The "transfer impedance" (from Current Probe Instruction Manual) is -8.2 dB below one ohm. The corrected level then is 15 + (-20) - (-8.2) = 3.2 dB above one microampere/kHz in the test sample lead.

3.34 RADIATED BROADBAND SIGNAL MEASUREMENTS

When a Rod (92221-2 or 92222-2) or Loop (92938-2) Antenna is used and the RFI Meter is calibrated using the BB Cal Figures, as described in Paragraph 3-9, step "f", impulse interference levels may be computed either in terms of microvolt/meter/kHz, or in dB above one microvolt/meter/kHz. In addition, with a rod antenna the "antenna induced" voltage (or open circuit antenna) may be computed either in terms of microvolts/kHz, or in dB above one microvolt/kHz. These computations are carried out as follows:

a) MEASUREMENTS IN DB ABOVE ONE MICROVOLT/METER/kHz: Add the meter reading in dB, the ATTENUATOR setting in dB, and the appropriate "antenna correction factor" in dB from Chart 1 or 2 in the Calibration Charts (Refer to Figures 3-2 and 3-3 for typical charts).

NOTE

Chart 1 (Figure 3-2) is used for measurements with the 92221-2 and 92222-2 Rod Antennas, while Chart 2 (Figure 3-3) is used for measurements with the 92938-2 Loop Antenna.

EXAMPLE: With the one-meter (86-inch) Rod Antenna as the signal pickup device, a meter reading of 15 dB is obtained for a 60 kHz signal at an ATTENUATOR setting of +20 dB. The "antenna correction factor" (from Chart 1) is 37 dB. The signal level then is 15 + 20 + 37 = 72 dB above one microvolt/meter/kHz.

b) MEASUREMENTS IN MICROVOLTS/METER/kHz:

1. Use the measurement procedures of subparagraph "a" above.
2. Convert the result in dB above one microvolt/meter/kHz to microvolts/meter/kHz using Table 3-6.

EXAMPLE: 72 dB above one microvolt/meter/kHz (from the preceding example) equals 4000 microvolts/meter/kHz (Table 3-6).

c) MEASUREMENTS IN DB ABOVE ONE MICROVOLT/kHz ANTENNA INDUCED: Add the meter reading in dB, the ATTENUATOR setting in dB, and the "high impedance factor" (in dB) from Chart 1 in the Calibration Charts (Refer to Figure 3-2 for a typical chart).

EXAMPLE: With the one-meter (86-inch) Rod Antenna as the signal pickup device, a meter reading of 15 dB is obtained for a 60 kHz signal at an ATTENUATOR

setting of +20 dB. The "high impedance factor"(from Chart 1) is 37 DB. The signal level then is 15 + 20 + 37 = 72 dB above one microvolt/kHz antenna induced. (Note that the "high impedance factor" would also apply if the 53" Rod Antenna were used.

d) MEASUREMENTS IN MICROVOLTS/kHz ANTENNA INDUCED:

1. Use the measurement procedure of sub-paragraph "c" above.
2. Convert the result in dB above one microvolt/kHz to microvolts/kHz using Table 3-6.

EXAMPLE: 72 dB above one microvolt/kHz (from the preceding example) equals 4000 microvolts/kHz antenna induced (Table 3-6).

3.35 MEASUREMENT OF RANDOM INTERFERENCE

The following sub-paragraphs apply to those users of RFI instrumentation who are concerned with the measurement of random type signals, as differentiated from impulse type interference. This is typically the case where a more accurate treatment of data is required than can be obtained with the general broadband (impulse) approach.

a) DEFINITION: The term "random interference" was defined in Paragraph 3-27, "b", but is repeated here as a general introduction to the subject.

b) RANDOM INTERFERENCE: When dealing with strictly random type interference, independent of Military Specifications, special measurement techniques may be employed when accurate data processing is required (such as correlating data obtained from different bandwidth receivers). Random interference can be defined as overlapping pulses that are both random in spacing and amplitude. Typical sources of random interference are cosmic noise, corona discharges, shot noise from

vacuum tubes, and ionized gas discharges. Because of the very nature of its varying amplitude characteristics, random interference is difficult to measure using the PEAK detector function. For this reason, the QP and FI detector functions are preferred.

c) BANDWIDTH RELATIONSHIP: As the bandwidth is changed, the usual RFI Meter (having Gaussian response characteristics) responds differently to an "impulse" type signal than it does to a "random" type signal. The RFI Meter output varies in direct proportion to the impulse bandwidth for a given impulse signal applied at the RF input. However, for a given random signal input, the RFI Meter output varies as the square root of the random noise bandwidth ratio. The following measurement procedures are based upon this latter treatment.

d) CALIBRATION: Calibrate the RFI Meter as described for a narrowband (CW signal (Refer to Paragraph 3-9, step "e").

e) BANDWIDTH: Random interference levels should be measured in the BROAD position of the BAND WIDTH switch. Use of the BROAD RFI Meter bandwidth provides much better sensitivity to random signals, and also achieves a better shape factor (Gaussian response) to amplify and shape the random signals correctly. Use the "Random Noise Bandwidth" value, which is 0.7 times the "Impulse Bandwidth" listed in the Calibration Charts under "Bandwidth Data"

f) DETECTOR FUNCTIONS: Any of the three detector functions (FI, QP, or PEAK) can be used. As mentioned previously, a PEAK measurement is more difficult to obtain due to the random, or indeterminate, level of the signal. The FI detector function provides an average measurement of the random signal. This in turn is approximately 11 dB below the peak value measured with the QP and PEAK detector functions. In general, an FI measurement is more closely associated with the signal power, while a QP measurement is more closely associated with the interference level of the signal.

g) MEASUREMENT TERMS: The measurement terms involve bandwidth, as the random "noise" signal is much wider than the bandpass of the RFI Meter (Refer to Table 3-4). The measurement terms are:

1. Conducted signals; microvolts/kHz (or dB above one microvolt/kHz) and microamperes/kHz (or dB above one microampere/kHz).
2. Radiated signals; microvolts/meter/kHz (or dB above one microvolt/meter/kHz) for a rod or loop antenna, or microvolts/kHz (or dB above one microvolt/kHz) for antenna induced (rod antenna only) measurements.
3. Tesla, Gauss, Oersted and Ampere-turns per meter per MHz, magnetic field terms (For Loop Antenna Only).

h) CONVERSION OF TERMS FOR RANDOM NOISE:

1. To convert microvolts/kHz to microvolts/MHz, multiply by the square root of the bandwidth ratio, or $\sqrt{1000}$, = 33.333.

2. To convert dB above one microvolt/kHz to dB above one microvolt/MHz, add $20 \log_{10} 1000$, or 30.55 dB.

i) 50-OHM CONDUCTED MEASUREMENTS:

1. In terms of microvolts/kHz; multiply the meter reading in microvolts by the ATTENUATOR setting, and divide the result by the square root of the "Random Noise Bandwidth" of the RFI Meter, expressed in kHz.

EXAMPLE: With a meter reading of 30 microvolts, an ATTENUATOR setting of X0.1, and a random noise bandwidth of 2 kHz, the random interference level is (30 x 0.1)/ 2 = 3/1.41 = 2.12 microvolts/kHz.

2. In terms of dB above one microvolt/kHz; use the same procedure as in "1" above, and convert the result in microvolt/kHz to dB above one microvolt/kHz using Table 3-6.

EXAMPLE: 2.12 microvolts/kHz (from the preceding example) equals 6.5 dB above one microvolt/kHz (Table 3-6).

3. Other conducted measurements (using the 92943-1 Rod Antenna Coupler and 90081-4 Impedance Matching Network, or an RF Current Probe) are made the same as in "1" and "2" above, only adding and dividing respectively by the "high impedance factor" and the "transfer impedance".

j) RADIATED SIGNAL MEASUREMENTS:

1. In terms of microvolt/meter/kHz; add the meter reading in dB, the ATTENUATOR setting in dB, and the appropriate "antenna correction factor" in dB from Chart 1 or 2 in the Calibration Charts (Refer to Figures 3-2 and 3-3 for typical charts). Convert the sum to microvolts/meter using Table 3-6, and divide the result by the square root of the "Random Noise Bandwidth" of the RFI Meter in kHz.

NOTE

Chart 1 Figure 3-2 is used for measurements with the 92221-2 and 92222-2 Rod Antenna, while Chart 2 (Figure 3-3) is used for measurements with the 92938-2 Loop Antenna.

EXAMPLE: With the one-meter (86-inch) Rod Antenna as the signal pickup device, a meter reading of 20 dB is obtained for a 60 kHz signal at an ATTENUATOR setting of -40 dB. The "antenna correction factor" (from Chart 1) is 37 dB, and the random noise bandwidth is 2 kHz. Then, 20 + (-40) + 37 = +17 dB above one microvolt/meter, or (from Table 3-6) 7.1 microvolts/meter. Then, 7.1/ 2 = 7.1/1.41 = 5.03 microvolts/meter/kHz.

2. In terms of dB above one microvolt/meter/kHz; use the measurement procedure of "1" above, and convert the result in microvolts/meter/kHz to dB above one microvolt/meter/kHz using Table 3-6.

EXAMPLE: 5.03 microvolts/meter/kHz (from the preceding example) equals 14 dB above one microvolt/meter/kHz (Table 3-6).

3.36 OPERATING POWER SOURCES

3.37 The RFI Meter operates from the internal battery, both during portable use, and when connected to an external AC power source. The battery can be charged with the equipment operating, and the RFI Meter may also be operated from the battery charger if desired (with the battery removed).

3.38 OPERATION FROM THE INTERNAL BATTERY

A fully charged battery will provide approximately 40 hours of operating time before requiring a recharge. The battery voltage is monitored on the BATTERY meter, which has an expanded scale (12 to 17 volts) to facilitate determining the battery condition. The percent of battery capacity may be determined from the battery voltage by reference to the chart in Figure 3-5. To operate the RFI Meter from the internal battery, proceed as follows:

a) Set the POWER switch to the ON position.

b) Check the battery condition by observing the BATTERY meter: The meter should indicate in the white portion of the scale.

c) If the BATTERY meter indicates in the red portion of the scale the battery is discharged, and the RFI Meter must be switched OFF to avoid damaging the battery.

NOTE

When discharging a fully charged battery, the voltage drops rapidly at first, then remains fairly constant until the cells are almost completely discharged. At this time discontinue further discharging. If the battery is left unused in a fully, or partially charged condition, a slight discharge occurs but this is not detrimental to the battery.

3.39 OPERATION FROM EXTERNAL AC POWER SOURCE

The internal battery charges while the RFI Meter is operated from an external AC power source. To operate the RFI Meter from an external AC power source, proceed as follows:

a) Set the 105V-125V/210V switch on the front panel to the position corresponding to the available line voltage.

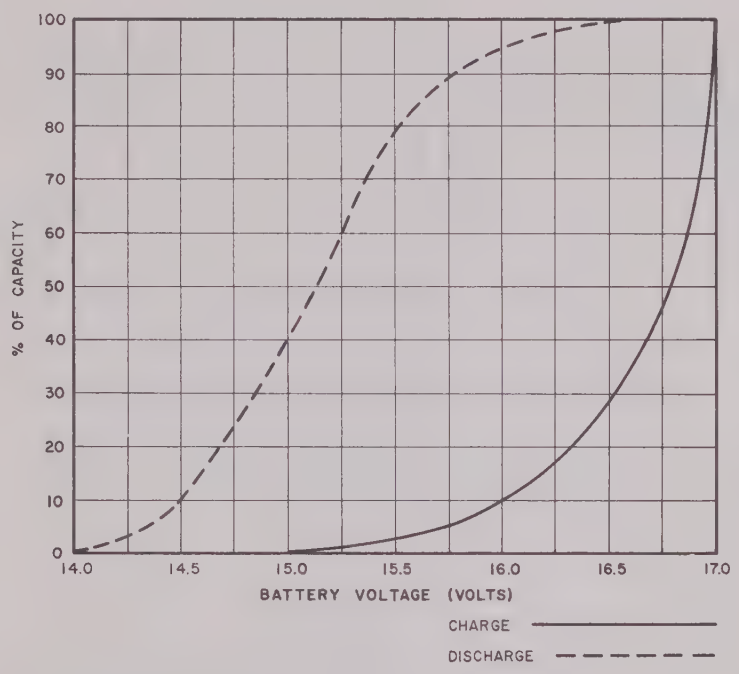


Figure 3-5. Battery Capacity, Charge vs. Discharge

NOTE

To change the switch position, first remove the screw and guard bracket; change the position; then re-install the bracket on the opposite side, tighten the screw as necessary.

b) Connect the six-foot AC Power Cable (91258-1) to the POWER Receptacle on the front panel. Connect the other end to the AC power source.

c) Set the POWER switch to the ON position.

NOTE

Full battery voltage (blue line on the BATTERY meter scale) will be achieved with approximately 16 hours operation. However, approximately 28 hours additional charging time is required to obtain a fully charged battery.

WARNING

When operating from an external AC power source, do not pull the power connector or throw the bench power switch to remove power. Always set the RFI Meter POWER switch to the OFF position first.

3.40 OPERATION FROM THE BATTERY CHARGER

The RFI Meter may be operated from the battery charger if the battery is removed from the equipment. This is accomplished in the same manner as operation from an external AC power source (Paragraph 3.39), as the battery charger produces a regulated 12-volt output.

NOTE

The BATTERY meter may indicate slightly above full-scale without an internal battery, but this will not damage the meter.

3.41 CHARGING THE BATTERY

The internal battery consists of 12 rechargable 1.25 volt NiCa cells (Sonotone Type S104-C). The cells are series connected, and housed in an aluminum case. The amount of charge in percent of capacity may be determined from the battery voltage by reference to the chart in Figure 3-5. To charge the battery, proceed as follows:

a) Perform steps "a" and "b" of Paragraph 3-39.

b) Set the POWER switch to the CHARGE position.

NOTE

Full battery voltage (blue line on the BATTERY meter scale) will be achieved in approximately 12 hours from a completely discharged condition without operating the RFI Meter. However, approximately 18 hours additional charging time is required to obtain a fully charged battery. When charging a fully discharged battery, the voltage rises rapidly at first, then starts to stabilize. When the battery is charged to 50-percent of its capacity, the voltage remains fairly constant.

SECTION IV

PRINCIPLES OF OPERATION

4.1 GENERAL

4.2 This section covers the principles of operation of the STODDART Model NM-12AT RFI Meter. The section is divided into a functional discussion, and a circuit analysis of the equipment.

4.3 FUNCTIONAL DISCUSSION

4.4 The Functional discussion that follows is based on the Block Diagram (Figure 4-1).

4-5 SIGNAL PICKUP DEVICES

The various signal pickup devices for the NM-12AT fall into several categories, as follows:

a) LOOP ANTENNA AND COUPLER: The Collapsible Loop Antenna and Loop Antenna Coupler, 92938-2, is used for radiated magnetic field measurements. The single-turn loop has an area of $0.73m^2$, and represents a low source impedance. The coupler (built into the base section of the loop) in turn provides a match from this low impedance to the 50-ohm input of the RFI Meter. Selectable tuned circuits are included in the coupler to provide the proper impedance match over the complete frequency range of the equipment.

b) LOOP PROBE: The Loop Probe, 90799-3, is a small hand held probe used for radiated magnetic field measurements. The probe is not calibrated, and is useful for comparative signal measurements. The Loop Probe represents a low source impedance, and is used in conjunction with the Loop Antenna Coupler.

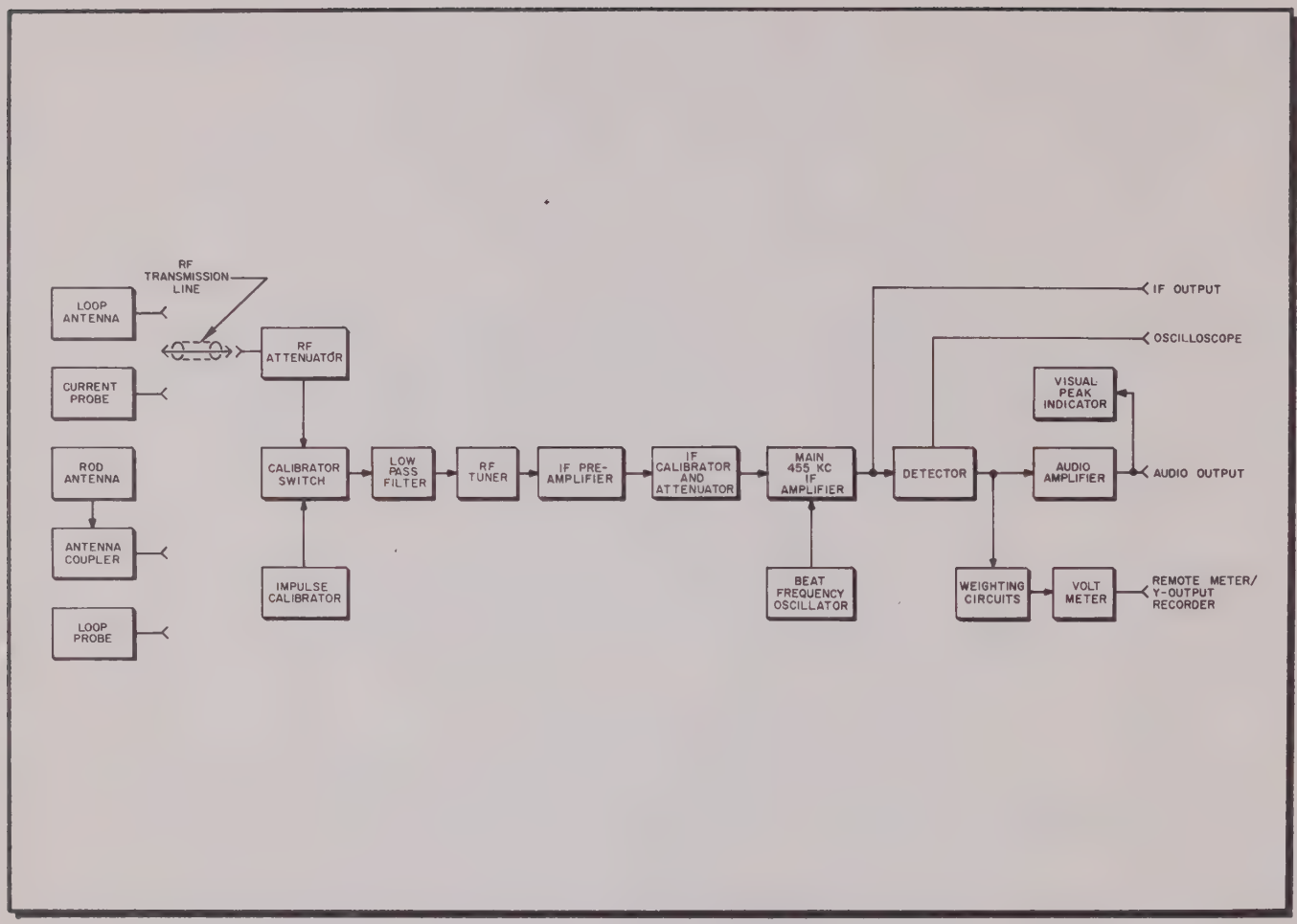


Figure 4-1. STODDART Model NM-12AT Functional Block Diagram

c) ROD ANTENNAS AND COUPLER: Two telescopic rod antennas are available, and are used for radiated electric field measurements. The 86-inch rod (92221-2) has an effective electrical height of one meter, while the 53-inch rod (92222-2) has an effective electrical height of 1/2-meter. The rod antennas represent a high source impedance. The Rod Antenna Coupler, 92943-1, in turn provides a match from this high impedance to the 50-ohm input of the RFI Meter. Selectable tuned circuits are included in the coupler to provide the proper impedance match over the complete frequency range of the equipment.

d) HIGH IMPEDANCE INPUT: The NM-12AT may be used as a high impedance RF voltmeter. In this application, the Impedance Matching Network, 90081-4, is used in conjunction with the Rod Antenna Coupler to provide a proper impedance match to the 50-ohm input of the RFI Meter.

e) RF CURRENT PROBE: The RF Current Probe is used for conducted RF interference measurements. The current probe is a "clamp-on" RF current transformer, and is connected directly to the 50-ohm input of the RFI Meter.

4.6 RF ATTENUATOR

The signal at the RF INPUT receptacle is applied to the RF Attenuator. This is a seven-position step attenuator, and has an overall range from 0 to 100 dB, selected by the ATTENUATOR knob. The RF Attenuator is mechanically linked with the IF Attenuator which inserts an additional 20 dB of signal attenuation in all but the -40 dB (X0.01) position. The two attenuators thus provide for a total signal attenuation range of 0 to 120 dB.

4.7 CALIBRATOR SWITCH

The signal from the RF Attenuator is applied to the Calibrator Switch, together with the output from the Impulse Calibrator. The Calibrator Switch is mechanically linked with, and actuated by the FUNCTION switch. In all positions of the FUNCTION switch except CAL, the signal from the RF Attenuator is applied to

the Low Pass Filter. However, in the CAL position, the input signal is shunted to ground and the Impulse Calibrator output is applied to the Low Pass Filter.

4.8 IMPULSE CALIBRATOR

The Impulse Calibrator is a multi-vibrator, and is energized in the CAL position of the FUNCTION switch. The square-wave output from the multivibrator is applied to a delay line which produces one-microsecond pulses. These pulses then constitute a standard calibrating signal source across the complete frequency range of the RFI Meter.

4·9 LOW PASS FILTER

The signal from the Calibrator Switch is applied to the Low Pass Filter. The filter has an upper cutoff frequency of approximately 370 kHz to provide image rejection from signals above the tuning range of the RFI Meter.

4·10 RF TUNER

The RF Tuner consists of an RF Amplifier, local oscillator, and a diode ring modulator:

a) RF AMPLIFIER: The signal from the Low Pass Filter is applied to a tuned input circuit, selected by the BAND switch, and resonated to the desired frequency by the TUNING control. The output from the tuned circuit is then applied to a single-stage balanced RF amplifier that drives the diode ring modulator.

b) LOCAL OSCILLATOR: The local oscillator operates 455 kHz above the input signal frequency to produce the 455 kHz intermediate frequency. The tuned circuit is selected by the BAND switch, and again resonated to the desired frequency by the TUNING control. The local oscillator output is also applied to the diode ring modulator.

c) DIODE RING MODULATOR: The diode ring modulator functions as a balanced mixer, producing the 455 kHz intermediate frequency applied to the IF Preamplifier.

4.11 IF PREAMPLIFIER

The IF Preamplifier established the overall bandwidth of the receiver. The 455 kHz output from the diode ring modulator is applied to a two-stage amplifier. An LC bandpass filter in this section produces a nominal 2.5 kHz bandwidth for the signal. In the BROAD position of the BAND WIDTH switch this signal is applied to the IF Calibrator and Attenuator circuit. In the NARROW position of the BAND WIDTH switch the preamplifier output is applied through a 455 kHz crystal bandpass filter to produce a nominal 100 Hz bandwidth. An additional stage of amplification is employed following the crystal filter to compensate for the insertion loss before the signal is applied to the IF Calibrator and Attenuator.

4.12 IF CALIBRATOR AND ATTENUATOR

The signal is applied across the IF Calibrator to the IF Attenuator:

a) IF CALIBRATOR: The IF Calibrator (CAL control) provides a signal gain control function. This permits the RFI Meter to be standardized at the measurement frequency using the Impulse Calibrator output as the reference to assure the repeatability of measurements.

b) IF ATTENUATOR: The IF Attenuator is mechanically linked to the RF Attenuator (Paragraph 4-6), and also to the FUNCTION switch. When the FUNCTION switch is set to the CAL position the 20 dB of IF attenuation is removed (regardless of the ATTENUATOR setting). This in turn makes the RFI Meter gain standardization independent from the ATTENUATOR setting.

4.13 MAIN IF AMPLIFIER

The Main 455 kHz IF Amplifier consists of four stages, the first two of which are AGC controlled. The AGC voltage is derived from the Weighting Circuits, and is applied to voltage variable capacitance diodes in the first two stages to provide AGC action in the IF amplifier. This in turn provides an approximate logarithmic scale for the panel meter. The output of the IF amplifier is then applied to the detector, and also to the IF OUTPUT receptacle.

4.14 BEAT FREQUENCY OSCILLATOR

The Beat Frequency Oscillator is energized when the FUNCTION switch is set to the BFO position. When energized, the oscillator produces a 456 kHz signal that is injected into the third (driven) stage of the Main IF Amplifier. This injected signal then mixes with the 455 kHz IF signal to permit audible reception of unmodulated carriers, or CW type signals.

4.15 DETECTOR

Two separate diode detectors are used, as follows:

a) AUDIO DETECTOR: The 455 kHz IF signal is demodulated by the audio detector and applied to the Audio Amplifier and Visual Peak Indicator circuits. The audio detector output is also applied to the OSCILLOSCOPE receptacle.

b) WEIGHTED DETECTOR: The 455 kHz IF signal is demodulated by the weighted detector and applied to the weighting circuits. To provide linear detection at low signal levels, an 850 kHz bias signal is developed and applied to this detector.

4.16 AUDIO AMPLIFIER

The output from the audio detector is applied across the AUDIO control to a four-stage amplifier, terminating in a push-pull output stage. The 600-ohm output from this stage is then applied to the AUDIO receptacle, and also to the visual peak indicator circuit.

4.17 VISUAL PEAK INDICATOR

The visual peak indicator circuit consists of a two-stage amplifier, and the PEAK meter. When the FUNCTION switch is set to the PEAK position the AUDIO control is "disabled" and a controllable reverse bias voltage (slideback peak function) is applied to cut-off the audio amplifier. The PEAK control adjusts this bias until it equals the peak signal level applied to the amplifier, at which time a "null" is indicated on the PEAK meter and the actual peak signal level is indicated on the front panel meter.

4.18 WEIGHTING CIRCUITS

The output from the weighted detector is applied to circuits that modify the demodulated signal in accordance with the selected measurement function. When the FUNCTION switch is set to the FI position, the "average" signal value is used, while in the QP position a "weighted" value is used. The appropriately modified detected signal is then applied to a metering amplifier, and the output is displayed on the panel meter. The metering amplifier output is also applied to the Y-OUTPUT receptacle, where it is available for use with a remote meter, or an external recorder. (Note that both terminals of the "Y" output are above ground).

4.19 CIRCUIT ANALYSIS

4.20 The circuit analysis that follows is based on the Schematic Diagrams of the Input Devices (Figure 4-2), and the RFI Meter (Figure 4-3).

4.21 INPUT DEVICES

The basic input devices consist of two Rod Antennas, the Rod Antenna Coupler, and the Collapsible Loop Antenna assembly.

4.22 ROD ANTENNAS AND COUPLER (Figure 4-2).

a) ROD ANTENNAS: The two telescopic Rod Antennas can be extended to a maximum length of 86 and 53 inches, respectively.

When fully extended they exhibit an approximate capacity of 24 picofarads, and represent a very high impedance source compared to the 50-ohm input impedance of the RFI Meter (varying from approximately 650 kilohms at 10 kHz to 25 kilohms at 250 kHz). The Rod Antenna Coupler is therefore used to match this high impedance source to the 50-ohm input.

b) ROD ANTENNA COUPLER: The Rod Antenna Coupler consists of a BAND switch, S501, and four impedance matching transformers, T501 through T504. The coupler is also suitable for use in making high impedance conducted measurements. In this case the Rod Antenna is removed, and the Impedance Matching Network is substituted in its place. In this configuration the input capacity remains 24 picofarads.

4.23 LOOP ANTENNA AND COUPLER

The Loop Antenna and Coupler (Figure 4-2) is an integrated assembly exhibiting the following characteristics:

a) LOOP ANTENNA: The Loop Antenna is a collapsible, single-turn diamond configuration, consisting of approximately 11 feet of coaxial cable. The loop exhibits an inductance of 4.9 microhenries, and represents a very low impedance source compared to the 50-ohm input impedance of the RFI Meter. The Loop Antenna Coupler is therefore used to match this low impedance source to the 50-ohm input.

b) LOOP ANTENNA COUPLER: The Loop Antenna Coupler consists of a BAND switch, S601, and four impedance matching networks. The impedance matching networks consist of transformer T601, and coupling capacitors C601 through C604. As in the Rod Antenna Coupler, the frequency ranges of the coupler BAND switch positions correspond to those of the RFI Meter.

4.24 RFI METER

4.25 RF SECTION

The RF Section (Figure 4-3, Sheet 1) consists of the RF Attenuator, Calibrator Switch, Impulse Calibrator, and the RF Tuner. Each circuit is separately packaged, and carefully shielded to minimize pickup of noise, or other interference.

4.26 RF ATTENUATOR

The signal at the RF INPUT receptacle, J101, is applied through a coaxial cable to the RF Attenuator, Z101. The ATTENUATOR switch, S101, has seven positions, however, in the first two (-40 and -20 dB) the signal is not attenuated. The remaining five positions (0 through +80 dB) are connected to a five-step 50-ohm ladder network, R401 through R411. The ladder network sequentially introduces 20 through 100 dB of attenuation to the input signal, while output from the attenuator appears at receptacle J114.

CAUTION

The precision resistances in the attenuator have a maximum power dissipation rating of 0.5 watt. Therefore, care must be exercised that the total signal input power does not exceed this rating.

4.27 CALIBRATOR SWITCH

The output of the RF attenuator is applied to the two-pole Calibrator Switch, S106, which is mechanically linked to the FUNCTION switch, S103. In all positions of the FUNCTION switch except CAL, the input signal is then applied to the RF Tuner, A101. However, in the CAL position S106B connects the output of the Impulse Calibrator, Z103, to the RF Tuner input at receptacle J103. Switch section S106A then shunts the attenuator output to ground, preventing spurious signals from being capacity coupled through the switch to the tuner input.

4.28 IMPULSE CALIBRATOR

The Impulse Calibrator, Z103, provides a standard calibrating signal source within the RFI Meter, producing a spectral intensity of 10 microvolts/kHz over the complete tuning range of the equipment. When the FUNCTION switch, S103, is set to the CAL position +12 volts is applied to a multivibrator, Q115 and Q116. The multivibrator is free-running, and produces a square-wave output having a repetition rate of 28 PPS. The square-wave output alternately charges and discharges the 0.5 microsecond delay line, DL101, in the collector circuit of Q116. This action produces an output pulse train of 1 microsecond pulse width, and approximately 2.5 volts amplitude, that is applied across an attenuator network consisting of R131 through R134. The attenuator network is selected to produce a spectral intensity output of exactly 10 microvolts/kHz across the 50-ohm load.

4.29 RF TUNER

The RF Tuner, A101, consists of a low pass filter, balanced RF amplifier, local oscillator, and a diode ring modulator, as follows:

a) LOW PASS FILTER: The signal at J103 (either the input signal from the RF Attenuator, or output of the impulse calibrator) is applied to a four-section low pass filter, Z102. Input and output impedances of the filter are 50 ohms, and the circuit consists of an M-derived section at the input and output, with one constant-K and one M-derived center sections. The filter has an upper cutoff frequency approximately 370 kHz, thus providing a flat frequency response over the tuning range of the RFI Meter, while rejecting spurious signals above this range.

b) BALANCED RF AMPLIFIER: The output from the low pass filter is applied across the primary winding of one of four antenna transformers, T101, T103, T105, or T107, as selected by position of the BAND switch, S401A. The secondary windings of

the antenna transformers in turn are connected to the primary windings of the appropriate RF transformers, T102, T104, T106, or T108, forming a tuned input circuit. BAND switch section S401B grounds the unused input circuits, while section S401C connects the input tuning capacitor, C109A, across the selected circuit. The secondary windings of the RF transformers are center-tapped to apply the signal, as selected by S401E, to the base inputs of the balanced amplifiers, Q101 and Q102. The signal from the collectors of Q101 and Q102 is then applied across the input of the diode ring modulator, where it is mixed with the local oscillator output to produce a 455 kHz intermediate frequency.

c) LOCAL OSCILLATOR: The local oscillator, Q103, operates on the high side of the input signal frequency. The local oscillator tuned circuit consists of transformer T110 and capacitor C109B. BAND switch sections S401G and S401H select the appropriate padder and trimmer capacitors, C126 through C145, for each of the four frequency ranges. Negative temperature coefficient capacitors are used, providing a frequency stability better than one-percent from -15° to + 40° C. The signal from the collector of Q103 is then applied through C120 to the wiper of R116, across the input of the diode ring modulator.

d) DIODE RING MODULATOR: The diode ring modulator consists of CR101 through CR104, connected in a "bridge" configuration. The RF amplifier output, at the collectors of Q101 and Q102, is applied through a low pass filter across the bridge, while the local oscillator output from the collector of Q103 is injected at the wiper of R116. The low pass filter, C116, L405, L406, R110, and R111, has a cutoff frequency of approximately 400 kHz. This minimizes any conducted local oscillator output at the RF INPUT receptacle. The diode ring modulator functions as a balanced mixer, in which only the 455 kHz IF output appears across T109. The local oscillator signal is "balanced out" by adjustment of R116, in the network across the bridge, and also capacitor C146 on the output side. Capacitors C119, and C146 through C148, resonate

the primary winding of T109 to 455 kHz, while the secondary provides an impedance match of 50 ohms to the IF Preamplifier, Z113.

4.30 IF PREAMPLIFIER

The IF Preamplifier, Z113, consists of two sections; i.e., a two-stage broadband section, and a single-stage narrowband section. The preamplifier establishes the IF bandwidth of the RFI Meter at either 2.5 kHz, or 100 Hz, as follows:

a) BROADBAND: The 455 kHz output from the diode ring modulator is applied through capacitor C192 to a single-tuned circuit, T111 and C189, at the base of Q104. The collector output of Q104 in turn is applied through a double-tuned circuit to the base of Q105. The double-tuned circuit, T112, T113, C187, C188, and C197, establishes the skirt selectivity of the broadband section. The collector output of Q105 is then applied across a 50-ohm output circuit, T114 and C199, and through capacitor C201 to the BANDWIDTH switch, S110. In the BROAD position of S110 the output is applied to the CAL control, Z114, and has a nominal 6 dB bandwidth of 2.5 kHz.

b) NARROWBAND: When S110 is set to the NARROW position, the 50-ohm 455 kHz output from T114 is applied across the primary winding of T115. Transformer T115 provides a proper impedance match to the crystal filter, FL401, which establishes a nominal 100 Hz bandwidth. The output from FL401 in turn is applied through C204 to the base of Q106, where it is further amplified and applied across the primary winding of T116. The secondary winding of T116 provides a 50-ohm output impedance for the signal, which is then applied to the CAL control, Z114. The gain of Q106 is adjusted by R155, which is set to exactly compensate for the insertion loss of the crystal filter, so that the overall gain of the narrowband section is 0 dB.

4.31 CAL CONTROL

The 455 kHz output of the IF Preamplifier is applied across the CAL Control, Z114 (Figure 4-3, Sheet 2). The CAL Control consists of a bridged-T attenuator network, and functions to standardize the RFI Meter gain. The input and output resistances, R166 and R167, maintain a 50-ohm impedance through the control, while a double-gain potentiometer, R168A and R168B, functions as the variable attenuator. The CAL Control is completely shielded to minimize noise and/or interference pickup, and the output is applied to the IF Attenuator, Z115.

4.32 IF ATTENUATOR

The IF Attenuator, Z115, is mechanically linked with the RF Attenuator (Paragraph 4-25), and the FUNCTION switch, S103. The attenuator inserts a fixed 20 dB, and consists of a 50-ohm pi-network, R169 through R171, and a switch, S102. The switch linkage is such that it bypasses the IF Attenuator when the ATTENUATOR switch, S101, is in the -40 dB position, applying the 455 kHz signal directly to the IF Main Amplifier, Z116. In all other positions of the ATTENUATOR switch, the 20 dB IF attenuation is inserted into the signal path by S102, so that the total signal attenuation (as indicated by the ATTENUATOR setting) is the sum of the RF and IF attenuators. The FUNCTION switch is also linked to S102. This linkage inserts the 20 dB attenuation whenever the FUNCTION switch is set to the CAL position, regardless of the ATTENUATOR setting.

4.33 IF MAIN AMPLIFIER

The IF Main Amplifier, Z116, consists of three single-ended stages, Q107 through Q109, a push-pull output stage, Q110 and Q111, bias oscillator, Q112, and the detectors, CR106 and CR108. AGC is applied to the first two stages when the AGC switch, S109, is in the ON position. With AGC applied, the IF amplifier operates in a logarithmic mode, while when S109 is in the OFF position the

amplifier operates in a linear mode. The AGC level does not change the gain of the controlled stages, all stages operate at fixed gain. However, the AGC level does attenuate the IF signal, employing variable capacity diodes to provide the control function. Operation of the various circuits is as follows:

a) AGC DERIVATION: The AGC loop functions with two levels; i.e., the AGC "control" voltage, and the AGC "reference" voltage. The AGC "control" voltage is obtained from the wiper of the Log Range potentiometer, R226, and is a portion of the "weighted" signal displayed on the panel meter, M101. The AGC "reference" voltage is obtained from a voltage divider consisting of R227 and zener diode CR115, from the positive 12-volt bus.

b) AGC LOOP: The 455 kHz signal from the IF Attenuator, Z115, is applied across a "bridge" circuit, while the AGC "reference" voltage is applied to one side of the bridge, and the AGC "control" voltage appears at the center junction. The "bridge" circuit consists of transformer T147, which has a pair of voltage variable capacitance diodes, CR116 and CR117, connected in series between the two bifilar secondary windings. The bridge output is then taken at the junction of the diodes. In a balanced condition, the 455 kHz signals in the secondary windings cancel, thus the output (junction of CR116 and CR117) is "zero". However, in an unbalanced condition, the 455 kHz signals do not completely cancel, and an IF output appears at the diode junction. The degree of unbalance depends on the difference between the AGC "control" and "reference" voltages. When S109 is in the ON position an increase in signal amplitude produces a corresponding increase in the AGC "control" voltage, resulting in a balanced condition across the bifilar transformer windings. This attenuates the IF signal at the junction of the diodes. Conversely, a decrease in RF signal amplitude decreases the AGC "control" voltage, resulting in an unbalanced condition and reduces the IF signal attenuation. A similar "bridge" circuit, T140, CR118, and CR119, is used at the input to the second stage, Q108.

c) AGC CONTROLLED STAGES: The input 455 kHz IF signal is applied across the primary winding of T147, and the "controlled" output at the junction of CR116 and CR117 is then applied through C282 to the base of the first IF amplifier, Q107. The base bias for Q107 is derived from a voltage divider, R220 and R268, and temperature stabilized by diode CR112. The output at the collector of Q107 is similarly applied across the primary winding of T140, and the signal at the junction of CR118 and CR119 is applied through C281 to the base of the second IF amplifier, Q108. Base bias for Q108 is derived from R173 and R179, and temperature stabilized by CR113. The output at the collector of Q108 is then applied across a 455 kHz tuned circuit, T141 and C210.

d) DRIVER STAGE: The signal from T141 is coupled through C211 and applied across the primary winding of T142, which is resonated to 455 kHz by C212. The two tuned circuits form a filter, and improve the "skirt" selectivity of the IF amplifier. The secondary output from T142 is then applied to the base of the driver, Q109, with the base derived from R176 and R180, and temperature stabilized by CR110. The Dynamic Range potentiometer, R187, sets the overload capacity of the amplifier. The collector of Q109 is connected through a reverse biased diode, CR105, to the wiper of R187. Adjusting R187 then varies the level of reverse bias applied to CR105, which in turn limits the signal peaks at the collector of Q109. The collector output from Q109 is then applied across the primary winding of T143. Negative feedback is also applied to the driver. This is obtained from the collector of Q110 in the output stage, and applied through C202 to the emitter of Q109.

NOTE

Capacitor C202 must be disconnected prior to aligning the IF amplifier. This is necessary to prevent the negative feedback from affecting the alignment.

e) OUTPUT STAGE: The 455 kHz IF signal across the secondary of T143 is applied to the base of Q110 and Q111, which function as a push-pull IF output stage. This stage operates in a class "B" common emitter configuration, with base bias derived from a voltage divider consisting of R184 and R185, while the common emitter resistance, R186, is un-bypassed to provide degeneration. The collector output from Q110 and Q111 is then applied across the primary winding of T144, the IF output transformer. The secondary of T144 is resonated to 455 kHz by C218, and the output signal is applied to the detectors, CR106 and CR108, and also through C230 to the front panel IF OUTPUT receptacle, J120.

f) BAIS OSCILLATOR: The detector diodes, CR106 and CR108, exhibit non-linear characteristics at low conduction levels. As linear detection is required, a bias voltage is applied to the diodes in series with the IF output signal. This maintains the conduction level above the non-linear region. The bias oscillator, Q112, operates at approximately 850 kHz, with the oscillatory circuit consisting of T145 and C221. The base bias for Q112 is derived from a voltage divider consisting of R188 and R189, from the positive 12-volt bus. The bias output developed across the secondary winding of T145 is approximately 0.3 volt RMS, and is applied in series with the IF output from T144 to the junction of CR106 and CR108.

g) DETECTORS: Two separate detectors are used, CR106 and CR108. Diode CR106 applies the demodulated IF envelope to the Weighting and Metering Circuit, Z117, and also through C229 to the front panel SCOPE receptacle, J119. When the FUNCTION switch, S103, is set to the PEAK position, the output from CR106 is also applied to the Audio Amplifier and Peak Indicator Circuit, Z121. In all other positions of the FUNCTION switch, the output of diode CR108 is applied to the audio amplifier, with the front panel AUDIO potentiometer, R241, functioning as the diode load resistance.

4.34 BEAT FREQUENCY OSCILLATOR

The Beat Frequency Oscillator, Z112, permits audible reception of CW type signals. Setting the FUNCTION switch, S103, to the BFO position applies a positive 12 volts through R197 and R198 to the emitter of Q113, energizing the oscillator. The tuned circuit, T146 and C222, is resonated to 456 kHz, and the collector output of Q113 is coupled through C215 to the base of the IF driver, Q109. The 456 kHz BFO signal then heterodynes with the 455 kHz IF signal to produce an audible output from the detector. The base bias for Q113 is derived from a voltage divider, R195 and R196, while R198 and C225 comprise a filter to decouple the BFO signal from the positive 12-volt bus.

4.35 WEIGHTING AND METERING CIRCUITS

The Weighting and Metering Circuits, Z117, modify the detector output in accordance with the selected measurement function, and display the weighted output on the panel meter, M101.

4.36 WEIGHTING CIRCUITS

The term "weighting" refers to the specific RC time constants introduced into the detector output for the three measurement functions; i.e., field intensity, quasi-peak, and peak. These three measurement functions are calibrated to produce the same meter reading, in terms of RMS values, for an unmodulated CW signal. However, when modulated signals are measured, the meter readings will be different in each of the measurement functions. The weighting circuits perform as follows in each of the FUNCTION switch positions:

a) FIELD INTENSITY: When the FUNCTION switch, S103, is set to the FI position, a relatively short RC time constant is introduced into the detector output to follow any modulation components present on the RF signal envelope. The detector output is then filtered

so the resultant meter reading is proportional to the average value of the RF signal envelope. This is accomplished by applying the output from CR106 (across C227) to the diode load resistance, R201. The values of C227 and R201 establish the short RC time constant required at the SCOPE output. The detected signal is then applied to a filter network, C231 and R209, which provide the 600-millisecond charge and discharge FI time constant. This results in an output amplitude proportional to the average carrier level, that is then applied via S103D to the DC amplifier in the metering circuit, Q137 through Q139, for display on the panel meter, M101. The FI-1 potentiometer, R211, permits the meter tracking to be adjusted at the "low" end of the scale in the FI position.

b) QUASI-PEAK: When the FUNCTION switch, S103, is set to the QP position, the charge time constant is one-millisecond, while the discharge time constant is 600 milliseconds. This permits the detector output to provide a near peak meter reading for pulse type signals having a relatively fast repetition rate. In the case of pulse type signals having a lower repetition rate, the ratio of PEAK to QP reading increases. The QP function is useful in determining the percentage of modulation of an RF carrier as the percentage of modulation determines the ratio of QP to FI meter reading. Also, the shorter charge time constant of the QP weighting circuit reduces the response time, thereby enabling the operator to scan across a given band faster than in the FI function. This is accomplished by applying the output from CR106 to a detector load circuit consisting of C231 and R209. Capacitor C231 charges through CR106 in one-millisecond, and discharges through R209 in 600 milliseconds. This results in an output approaching the peak value of the input signal envelope. The difference between the output in this detector function and the actual peak value, depends on the modulation frequency. The output from C231 is then applied via S103D to the DC amplifier in the metering circuit. The QP-1 and QP-100 potentiometers, R210 and R207 respectively, permit the meter tracking to be adjusted at the "low" and "high" ends of the scale in the QP position.

c) PEAK: The PEAK position of the FUNCTION switch, S103, provides a "slideback" facility to measure peak signal values. In the PEAK position, the demodulated signal from CR106 is applied via S103B to the input of the Audio Amplifier and Peak Indicator Circuit, Z121, and the AUDIO potentiometer, R241, is removed from the circuit. An adjustable reverse bias level is also applied to CR106 in this position. The bias level is established by the front panel PEAK potentiometer, R203. Initially for a "peak" measurement, R203 is adjusted to the full clockwise position. This applies maximum reverse bias to CR106, preventing the diode from conducting. As R203 is rotated counter-clockwise, the reverse bias decreases, until a point is reached where the bias level is just below the input signal level. At this point CR106 conducts, developing an output across the diode load circuit, C227 and R202, that is applied to the audio amplifier, Q118 through Q122. The audio amplifier output in turn is applied to the peak indicator circuit, Q123 and Q124. The visual PEAK meter, M102, functions as the load for Q124. With no input to the audio amplifier (CR106 not conducting due to reverse bias) the white bar on M102 is all the way to the right (clockwise). At the point where CR106 conducts, the white bar moves to the left (counter-clockwise), and an audible signal will be heard in the headset, connected to the front panel AUDIO receptacle, J118. A DC voltage)proportional to the reverse bias on CR106) is also applied via S103D to the DC amplifier in the metering circuit. The PK-1 and PK-100 potentiometers, R218 and R206 respectively, permit the meter tracking to be adjusted at the "low" and "high" ends of the scale in the PEAK position.

d) BFO: When the FUNCTION switch, S103, is set to the BFO position, the detector weighting is the same as in the FI position.

e) CALIBRATE: When the FUNCTION switch, S103, is set to the CAL position, the detector weighting is the same as in the QP position.

4.37 METERING CIRCUIT

The metering circuit consists of a high stability three-stage DC amplifier, Q137 through Q139. A field effect transistor, Q137, is used to provide an extremely high input impedance, thus preventing excessive loading of the detector weighting circuits. Direct coupling is employed between stages, and the output, Q139, functions as an emitter follower to drive the panel meter, M101. The emitter output from Q139 is also applied through the Log Range potentiometer, R226, as the AGC "control" voltage to the IF Main Amplifier (Paragraph 4-32 "a"). A positive 9-volt level is obtained from the junction of CR115 and R227, which form a voltage divider from the positive 12-volt bus. This positive 9-volt level is applied to the meter, M101, and is also utilized as the AGC "reference" voltage (Paragraph 4-32 "a"). The response time of M101 is controlled by the METER switch, S105. In the SLOW position of S105, capacitor C232 is paralleled with the meter to increase the overall response time. The Y-OUTPUT receptacle, J121, also parallels the meter. A remote meter, or an external recorder may be connected at this point if desired.

4.38 AUDIO AMPLIFIER AND PEAK INDICATOR CIRCUIT

The Audio Amplifier and Peak indicator Circuit, Z121, consists of two separate sections. The audio section comprises two preamplifiers, an audio driver stage, and a push-pull output stage. The visual peak indicator section comprises a two-stage amplifier, and the visual PEAK meter, M102. In all FUNCTION switch positions except PEAK, the demodulated IF envelope from CR108 is applied across the AUDIO potentiometer, R241, to the audio amplifier input. However, in the PEAK position, the output from CR108 is not used, and S103B removes R241 from the circuit. In this case, the output from CR106 is applied to the audio amplifier, and the PEAK potentiometer, R203, determines the signal amplitude by setting the conduction point of CR106 (Paragraph 4-35 "c").

4.39 AUDIO AMPLIFIER

The selected detector output is applied through C233 and R242 to the base of the first audio pre-amplifier, Q118. The base bias for Q118 is derived from a voltage divider, R243 and R244, while R245 in the emitter is un-bypassed to provide degeneration. The collector output from Q118 is coupled through C234 to the base of the second preamplifier, Q119, where it is further amplified and applied through C236 to the audio driver, Q120. The base bias for Q119 is obtained from R247 and R266, and degeneration is provided by R267. The audio driver stage is again similar, however, a parallel resonant circuit is used in the collector load. This consists of L102 and C238, and resonates at approximately 3000 Hz to provide good high frequency response. The signal is then coupled through C239 to the push-pull output stage, Q121 and Q122. The output stage operates Class "B", in a complementary symmetric configuration with emitter follower output. Base bias for Q121 and Q122 is obtained from a voltage divider consisting of R251 through R253, and R259, while the 600-ohm impedance of the headset provides the output load. The output, from the junction of R255 and R256, is coupled through C240 to the front panel AUDIO receptacle, J118, and is also applied to the visual peak indicator circuit.

4.40 PEAK INDICATOR CIRCUIT

The audio amplifier output is applied through R229 and C268 to the base of Q123. Base bias for Q123 is obtained from R230 and R231, and the collector output is coupled through C265 to the base of Q124. Base bias for Q124 is obtained from R234 and R235, and visual PEAK meter, M102, forms the collector load. With no signal input (CR106 not conducting) Q124 is cut-off, therefore no current flows through M102 and the movable white bar is all the way to the right. However, when an audio signal greater than 10 millivolts is applied to the input, Q124 will conduct. This causes the white

bar to move toward the left, indicating the input signal has overcome the reverse bias applied to the detector. The collector current of Q124 is limited to 100 microamperes by R236, and the parallel connected network, R237 and C267, accelerates the meter movement.

4.41 POWER SUPPLY

The RFI Meter operates from either a single-phase AC power source of 115 or 230 volts, 50 to 400 Hz, or from an internal rechargable battery. When an external AC power source is used, the battery is normally on charge while the RFI Meter is in operation. However, the battery may also be charged without turning the RFI Meter "ON". Additionally, the RFI Meter may be operated from an external AC power source with the battery removed. A fully charged battery will provide up to 40 hours of operation before requiring recharging. The battery voltage is monitored on the BATTERY meter, M103, located on the front panel. The power supply (Figure 4-3, Sheet 1) consists of a line filter, POWER switch, power transformer, battery, and a plug-in printed circuit board. The printed circuit board contains the bridge rectifier, charge regulator, and the voltage regulator circuits.

4.42 POWER INPUT CIRCUITS

The power input circuits comprise the Line Filter, Z122, POWER switch, S108, voltage selector switch, S302, and the power transformer, T302, as follows:

a) LINE FILTER: The AC power input from receptacle J301 is applied to an "H" type low-pass Line Filter, Z122. The filter has an upper cut-off frequency of 7 kHz, and is contained within a separately shielded case. The two 1/10-ampere line fuses, F301 and F302, are also located within the shielded case.

b) POWER SWITCH: The POWER switch, S108, has three positions; i.e., CHARGE, OFF, and ON. In both the CHARGE

and ON positions, the AC input is applied by S108A and S108B to the primary windings of the power transformer, T302, while the OFF position is open. Switch section S108C connects the output of the charge regulator circuit, and the battery, Z123, to the input of the voltage regulator circuit in the CHARGE and ON positions. Switch section S108D connects the output of the voltage regulator circuit to the BATTERY meter, M103, in the CHARGE position, while in the ON position it applies the voltage regulator output to the positive 12-volt bus.

c) POWER TRANSFORMER AND VOLTAGE SELECTOR SWITCH: The power transformer, T302, has two separate 117-volt primary windings. When the voltage selector switch, S302, is set to the 105V-125V position these windings are connected in parallel, while in the 210V-250V position they are connected in series.

4.43 POWER SUPPLY REGULATOR

The Power Supply Regulator, Z200, contains the bridge rectifier, a charge regulator circuit, and a voltage regulator circuit, as follows:

a) BRIDGE RECTIFIER: The nominal 33 volts AC from the secondary winding of T302 is applied across the bridge rectifier, CR307 through CR310. The rectifier output is filtered by C312, and applied to the input of the charge regulator circuit.

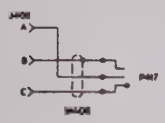
b) CHARGE REGULATOR: The DC output from the bridge rectifier is applied through R314 to the emitter of Q201, which functions as a series current regulator. An avalanche diode, CR311, together with R314 maintains the current through Q201 at a constant 170 milliamperes. This current is unaffected by either a power line or battery voltage change. The series regulator output at the collector of Q201 is then applied to a shunt current regulator, Q202, and also through CR317 to the battery, Z123. Diode CR317 prevents the battery from discharging back through the charging circuits. The shunt current

regulator permits a trickle charge current of 40 to 60 milliamperes to flow through the battery when it is fully charged (17 volts). The trickle charge may be adjusted with potentiometer R318, and the amount of shunt current through Q202 may be monitored between TP301 and TP302.

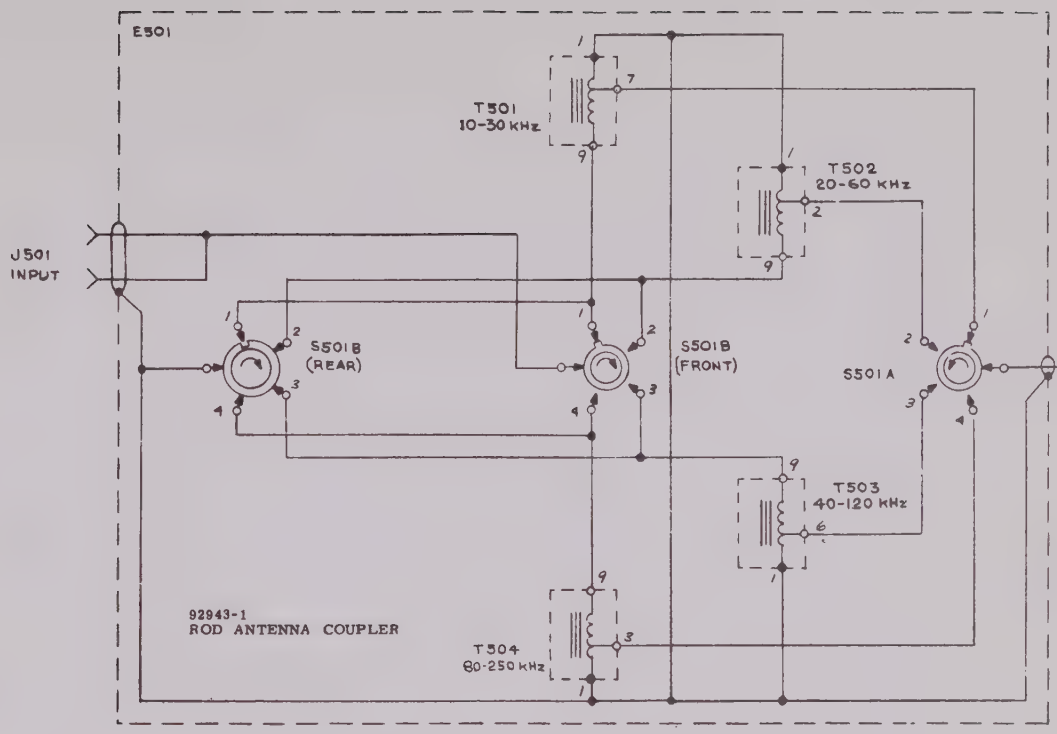
c) VOLTAGE REGULATOR: The battery voltage rises from 14 to 17 volts during "charge", and drops from 17 to 14 volts during "discharge". In either case the voltage applied to the RFI Meter is regulated to 12, $\pm$ 0.1 volts, by the series voltage regulator circuit, Q203 and Q204. Transistor Q203 functions as the series regulator, with avalanche diode CR314 providing the reference at the emitter of the sensing comparator, Q204. The voltage sensing network consists of R323 through R325, and two temperature compensating stabistors, CR315 and CR316. The regulated output level may be adjusted by potentiometer R324, if necessary. The BATTERY meter, M103, is connected between the battery and the regulated 12 volts, and therefore indicates the battery voltage above 12 volts.

92191-1
RF TRANSMISSION LINE

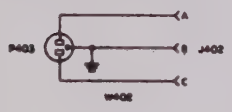
90075-2
REMOTE METER CABLE



90799-3
LOOP ANTENNA

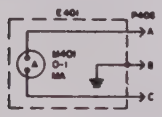


91258-1
A-C POWER CABLE



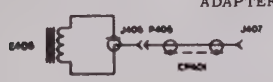
90074-1
HEADPHONE CABLE

90078-13
REMOTE METER

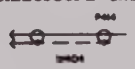


91550-1
CURRENT PROBE

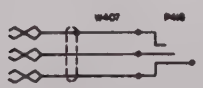
UG-201A/U
COAXIAL CONNECTOR
ADAPTER

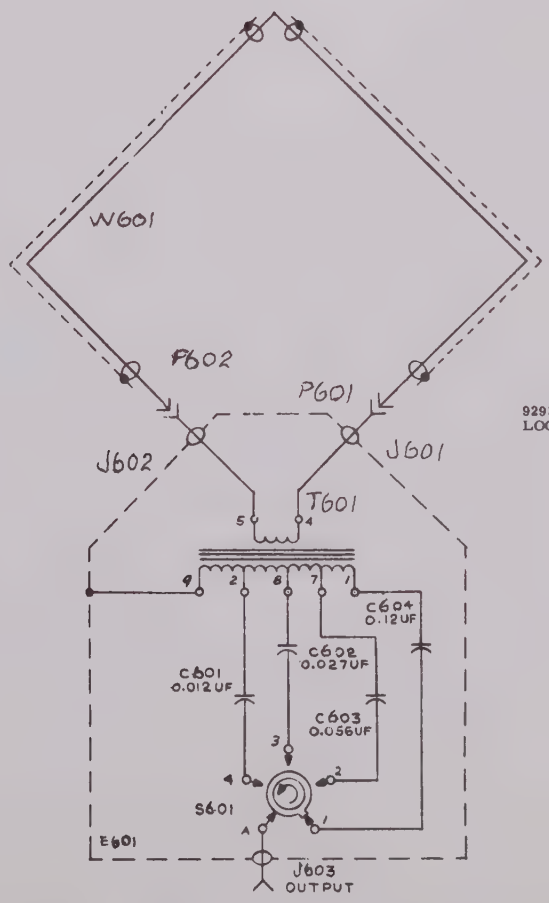


90071-1
OSCILLOSCOPE CABLE



90075-4
"Y" OUTPUT CABLE





92938-2
LOOP ANTENNA AND COUPLER

FIGURE 4-2. SCHEMATIC DIAGRAM – ACCESSORIES

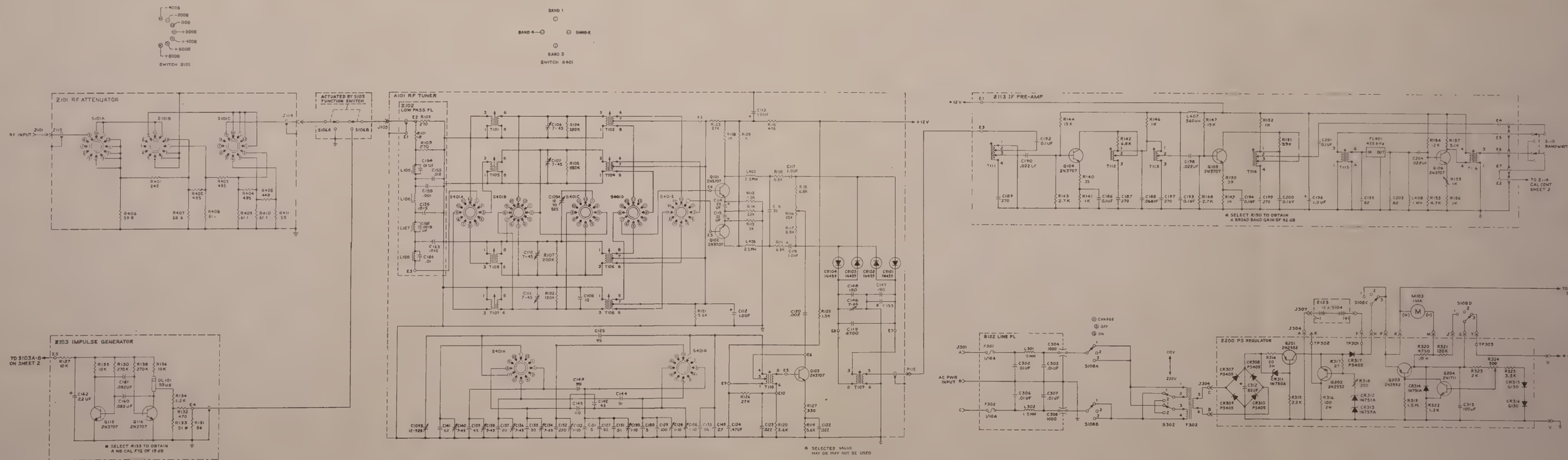
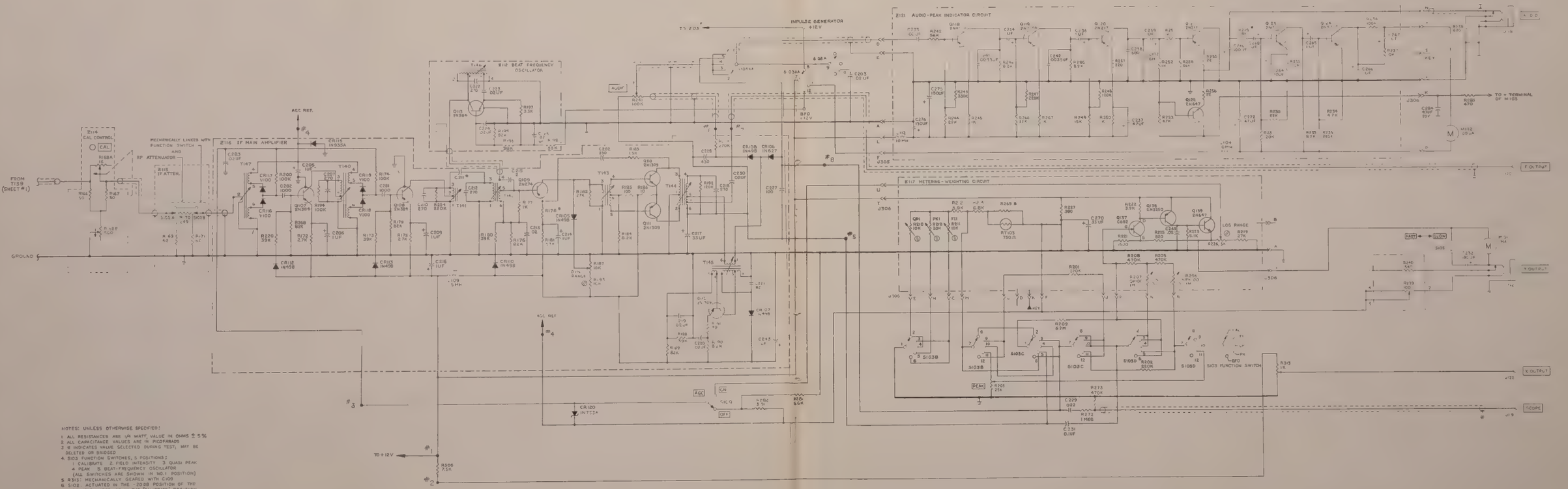


FIGURE 4-3. SCHEMATIC DIAGRAM - NM-12AT RFI METER (SHEET 1 OF 2)



NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCES ARE 1/4 WATT, VALUE IN OHMS ± 5%
2. ALL CAPACITANCE VALUES ARE IN MICROFARADS
3. # INDICATES VALUE SELECTED DURING TEST, MAY BE DELETED OR BRIDGED
4. S103 FUNCTION SWITCHES, 5 POSITIONS:
   1. CALIBRATE 2. FIELD INTENSITY 3. QUASI PEAK
   4. PEAK 5. BEAT-FREQUENCY OSCILLATOR
   (ALL SWITCHES ARE SHOWN IN NO.1 POSITION)
5. R313: MECHANICALLY GEARED WITH C109
6. S102: ACTUATED IN THE -20dB POSITION OF THE RF ATTENUATOR, OR IN THE 'CALIBRATE' POSITION OF THE FUNCTION SELECTOR
   (SHOWN IN NON-ACTUATED POSITION)

FIGURE 4-3 SCHEMATIC DIAGRAM - NM-12AT RFI METER (SHEET 2 OF 2)

SECTION V

MAINTENANCE

5.1 INTRODUCTION

5.2 This section contains general maintenance information, troubleshooting procedures, alignment and adjustment instructions, and recommended servicing for the solid-state circuitry and printed circuit boards.

5.3 GENERAL MAINTENANCE INFORMATION

5-4 BASIC REQUIREMENTS

Each STODDART NM-12AT RFI Meter is carefully checked following alignment and calibration at the factory, and no further internal adjustments are required prior to placing the equipment in operation. In the event of a failure or malfunction, troubleshooting or adjustments should only be conducted by technicians experienced in the maintenance and calibration of RFI Meters, and only if the proper test equipment is available.

5.5 TEST EQUIPMENT REQUIRED FOR MAINTENANCE

The test equipment required for troubleshooting, alignment, and/or calibration, is tabulated in Table 5-1.

TABLE 5-1. Test Equipment Required For Maintenance

DESCRIPTION	RECOMMENDED TYPE	USE
DC VOM	Triplett Model 630 (or equivalent	Transistor DC voltage measurements and power supply adjustment.
Signal Generator	Hewlett-Packard Model 606A/B and/or General Radio Model 1001A	RF and IF alignment; bandwidth measurement.
Impulse Generator	STODDART Model 93453-1, or 91263-1	Establishing Calibration Figure.
Headset (600-ohm)	STODDART Model 10796 (or equivalent)	Audio aid
Electronic Counter	Computer Measurements Corp., Model 707B (or equivalent)	RF and IF alignment; bandwidth measurement.
RF VTVM	Ballantine Model 314	RF and IF alignment
Step Attenuator	Hewlett-Packard Model 355B or D	Meter Scale tracking

5.6 REMOVAL OF RFI METER FROM CASE

The RFI Meter is secured to the case by eight (8) screws in the front panel. To remove the unit from the case, loosen these screws and lift out by the carrying handles on the front panel.

WARNING

Do not remove the RFI Meter from the case when the power cable is attached to the AC power source, or if the POWER switch is in either the ON or CHARGE position.

5.7 POWER REQUIREMENTS FOR ALIGNMENT

All alignment and meter scale tracking adjustments are made with the internal power supply regulator output voltage at 12 ±0.1 volts.

NOTE

If deviations are noted in the FREQUENCY dial calibration or meter scale tracking, or if the gain stabilization adjustment is difficult, check the power supply output voltage before attempting to align or adjust the RFI Meter.

5.8 ISOLATING MALFUNCTIONS

5.9 BASIC TROUBLESHOOTING PHILOSOPHY

Most malfunctions within the RFI Meter can be located by considering the unit as a conventional communications receiver with a "built-in" electronic voltmeter. Inspect the equipment carefully and try to isolate the malfunction visually. Check the operating controls for proper settings, as described in Section III. If one of the signal pickup devices is suspected as the source of trouble, check continuity through the device. If however, the malfunction is established to be in the RFI Meter, isolate the trouble to a particular section, then to the defective state.

5.10 TROUBLESHOOTING

Reference to the Troubleshooting Chart, Table 5-2, will aid in isolating the fault to a particular section of the RFI Meter. Once this has been accomplished, check the transistor element voltages, as tabulated in Table 5-3. A significant difference in one or more of these voltages should be considered cause for component checks in that stage.

TABLE 5-2. Troubleshooting Chart

MALFUNCTION	POSSIBLE REASON	PROCEDURE
During the charge or operation from the power line, the BATTERY meter fails to rise in the blue section.	Power line voltage is not connected to the power transformer.	1. Check the power line voltage. 2. Check Fuses F301 and F302. 3. Check switches S108 and S302.
	Battery charger is defective.	Check DC voltages on Q201, Q202.
	Battery is defective.	Check the individual battery cells.
Operation time of the fully charged battery is too short.	Battery is defective.	Check the individual battery cells.
Battery charge time is too long.	Battery charger is improperly adjusted.	Readjust battery charger (Paragraph 5-12, steps "e" and "f").
With FUNCTION switch in CAL position, no meter indication, but signal is audible in headset.	Metering circuit is defective.	Check voltage of Q137, Q138, Q139, and CR115.
	Impulse Generator not working.	Check DC voltages on Q115 and Q116.
Meter indicates, but signal is not audible in headset.	Audio amplifier is defective.	Check DC voltages on Q118 through Q122.
Visual PEAK indicator is not working.	Audio amplifier is defective.	Check DC voltages on Q118 through Q122.
	PEAK indicator circuit is defective.	1. Check DC voltages on Q123 and Q124. 2. Check AGC reference for +9 volts DC.

TABLE 5-2. Troubleshooting Chart (Continued)

MALFUNCTION	POSSIBLE REASON	PROCEDURE
Meter scale tracking cannot be adjusted	Bias oscillator is defective.	Check DC voltages on Q112.
Receiver is not working on one position of BAND switch.	RF or LO circuit for that band is defective.	Check the particular RF and LO circuits.
	BAND switch is defective.	Check the contacts of S401.
Receiver is not working on any position of BAND	RF amplifier is defective.	Check DC voltages on Q101 and Q102.
	LO is not operating.	Check DC voltages on Q102.
	IF preamplifier is defective.	Check DC voltages on Q104 through Q106.
	Main IF amplifier is defective.	Check DC voltages on Q107 through Q111.

TABLE 5-3. Transistor Voltages

Stage	Function	Type	V_E	V_B	V_C	Notes
Q101	RF Amplifier	2N3707	1.2	1.8	9.7	
Q102	RF Amplifier	2N3707	1.2	1.8	9.7	
Q103	Local Oscillator	2N3707	1.4	2.0	11.5	
Q104	IF Preamplifier, 1st Stage	2N3707	1.2	1.8	10.8	
Q105	IF Preamplifier, 2nd Stage	2N3707	1.2	1.8	10.8	
Q106	IF Preamplifier, Narrow Band	2N3707	2.8	3.4	12.0	
Q107	IF Main Amplifier, 1st Stage	2N384	8.2	8.0	.0	

TABLE 5-3. Transistor Voltages (Continued)

Stage	Function	Type	V_E	V_B	V_C	Notes
Q108	IF Main Amplifier, 2nd Stage	2N384	8.2	8.0	.0	
Q109	IF Main Amplifier, Driver Stage	2N274	8.2	8.0	.0	
Q110	IF Main Amplifier, Output Stage	2N1309	12.0	11.9	.0	
Q111	IF Main Amplifier, Output Stage	2N1309	12.0	11.9	.0	
Q112	Bias Oscillator	2N1309	4.1	3.9	.0	
Q113	Beat Frequency Oscillator	2N384	2.4	2.3	.0	FUNCTION switch in BFO.
Q115	Impulse Generator	2N3707	0.0	1.1	2.6	FUNCTION switch in CAL pos.
Q116	Impulse Generator	2N3707	0.0	1.1	2.6	FUNCTION switch in CAL pos.
Q118	Audio Amplifier, 1st Stage	2N217	11.4	11.2	4.5	
Q119	Audio Amplifier 2nd Stage	2N217	11.1	10.9	7.2	
Q120	Audio Amplifier, Driver Stage	2N217	10.9	10.7	2.1	Audio control down.
Q121	Audio Amplifier, Output Stage	2N217	7-8.5	6.8-8.3	.0	Audio control down.
Q122	Audio Amplifier, Output Stage	2N647	7-8.5	7.2-8.7	14-17	Audio control down.
Q123	Visual Peak Indicator, 1st Stage	2N835	0.8	1.5	6.0	
Q124	Visual Peak Indicator, 2nd Stage	2N835	0.0	0.3	12.0	White bar of M102 to the right.
Q137	Metering Circuit, 1st Stage	C682	5.8	5.5	11.8	With no signal.
Q138	Metering Circuit, 2nd Stage	2N3250	12.0	11.8	9.2	With no signal.

TABLE 5-3. Transistor Voltages (Continued)

Stage	Function	Type	V_E	V_B	V_C	Notes
Q139	Metering Circuit, 3rd Stage	2N647	9.0	9.2	12.0	With no signal.
Q201	Charge Regulator	2N2552	19.4	19.2	17.4	Battery fully charged.
Q202	Charge Regulator	2N2552	17.4	17.2	10.0	POWER switch ON
Q203	Voltage Regulator	2N2552	16.8	16.6	12.0	POWER switch ON
Q204	Voltage Regulator	2N1711	7.0	7.5	16.6	POWER switch ON.
CR115	Metering Circuit Reference Diode	1N935	V_z = 9V			

5.11 ALIGNMENT AND CALIBRATION

5.12 PRELIMINARY CHECKS AND SETTINGS

The following preliminary checks and settings should be performed prior to alignment and calibration of the RFI Meter:

a) Remove the RFI Meter from the case, as described in Paragraph 5.6.

b) Conduct a visual examination of the unit to ascertain that all circuit boards and major components are in place, and properly installed.

c) Check the front panel meter for mechanical zero. Adjust if necessary, with the meter mechanical zero adjusting screw.

d) Connect the AC Power Cable to the 115 volt, 60 Hz power source, and set the POWER switch to the ON position. Observe that the BATTERY meter on the front panel indicates a minimum of 16.4 volts; if not, set the POWER Switch to the CHARGE position and allow the batteries to charge to this level before continuing.

e) Using a DV Voltmeter, measure and record the voltage between Pin F on the Power Supply Regulator board, Z200, and the chassis. Then measure and record the voltage between Pin E and the chassis. The value at Pin E should agree with that at Pin F as follows:

1) Pin F (VDC) - 16.4 - 16.6 - 16.8

2) Pin E (VDC) - 3.5 - 5.5 - 8.0

NOTE

If the value at Pin E is not correct, adjust potentiometer R138 (Figure 5-1) until the proper value is obtained.

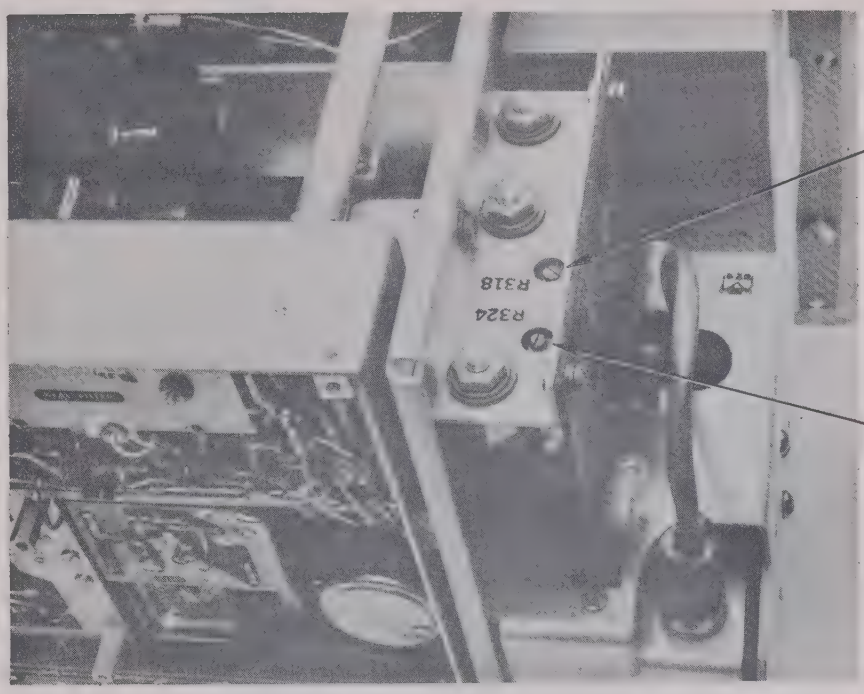
f) Using a DC Voltmeter, measure the voltage between the upper +12V (red wire) feed-thru terminal to the IF Preamplifier board, Z113, and chassis. This value should be 12 $\pm$ 0.1 volts; if not, adjust potentiometer R324 (2, Figure 5-1) until the proper value is obtained.

5.13 MAIN IF ALIGNMENT

The Main IF Amplifier, Z116, is aligned as follows:

a) Remove the RFI Meter from the case, as described in Paragraph 5.6.

b) Remove the shield plate covering the IF section and disconnect the RF Tuner output cable (Microdot connector) at receptacle J114.



KEY TO FIGURE 5-1

INDEX NO.	REF. DESIG	FUNCTION	PARA. REF.
1	R318	Regulator reference voltage adjustment	5-12, "e"
2	R324	Regulated +12 volt DC output adjustment	5-12, "f"

Figure 5-1. Power Supply Regulator Adjustments

KEY TO FIGURE 5-2

INDEX NO.	REF. DESIG	FUNCTION	PARA. REF.
1	Q112	Bias oscillator RF pickup point	5-13, "d"
2	T145	Bias oscillator frequency adjustment point	5-13, "e"
3	R183	IF feedback resistance	5-13, "f"
4	R187	Dynamic Range potentiometer	5-14, "f"
5	- - -	Signal Generator connection point to T142	5-13, "h"
6	T144	Slug adjustment	5-13, "j"
7	- - -	Signal Generator connection point to R168A	5-13, "k"
8	T140	Slug adjustment	5-13, "m"
9	T141	Slug adjustment	5-13, "m"
10	T142	Slug adjustment	5-13, "m"
11	T147	Slug adjustment	5-13, "m"
12	"E3"	Signal Generator connection point	5-15, "b"
13	T114	Slug adjustment	5-15, "d"
14	T112	Slug adjustment	5-15, "e"
15	T113	Slug adjustment	5-15, "e"
16	T111	Slug adjustment	5-15, "f"
17	R155	Narrow band gain potentiometer	5-15, "g"

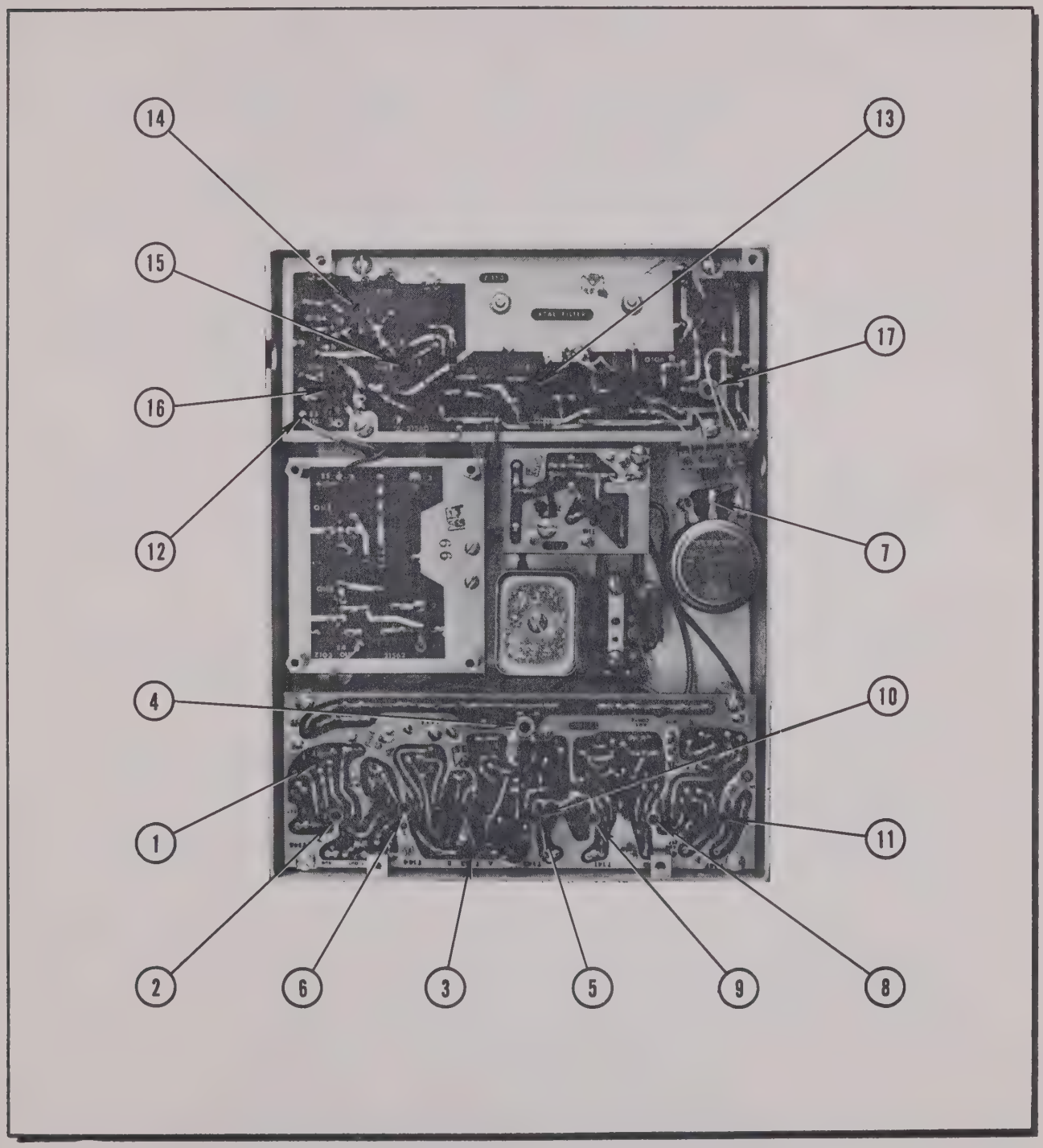


Figure 5-2. IF Amplifier and Preamplifier Alignment Adjustments

c) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To QP position
ATTENUATOR switch	To 0 dB position
AGC switch	To ON position
METER switch	To FAST position
CAL control	Full Clockwise
AUDIO control	Full counter-clockwise
BAND switch	To any position
TUNING control	To any position.

d) Connect the Electronic Counter input to the output of the Ballantine VTVM and place the VTVM probe within 1/2-inch of the bias oscillator, Q112 (1, Figure 5-2).

NOTE

Radiation from this oscillator is sufficient for adequate electrostatic pickup by the probe.

e) Note the bias oscillator frequency indication on the Electronic Counter. The frequency should be 850 kHz; if not, adjust the slug in transformer T145 (2, Figure 5-2), using an insulated tuning tool.

f) Locate the 1500-ohm resistance, R183 (3, Figure 5-2), on the rear (outward) side of the Main IF Amplifier board, Z116, and carefully unsolder one end.

NOTE

This opens the negative feedback loop between the IF output and driver stages.

g) Rotate the "Dynamic Range" potentiometer, R187 (4, Figure 5-2), fully counter-clockwise.

h) Connect the Electronic Counter to the high level output of the Signal Generator and connect the adjustable 50-ohm output to Pins 1 (ground) and 3 of transformer T142 (5, Figure 5-2).

i) Adjust the Signal Generator frequency to exactly 455 kHz (as indicated on the Electronic Counter) and set the output level to produce an "on-scale" reading on the front panel meter.

j) Using the insulated tuning tool, adjust the slug in transformer T144 (6, Figure 5-2) to obtain maximum indication on the front panel meter.

NOTE

Monitor the Signal Generator frequency on the counter, maintaining it at 455 kHz; reduce the output level as required to maintain an "on-scale" reading on the meter.

k) Reconnect resistance R183 (Step "f") and connect the Signal Generator output to the wiper of the CAL potentiometer, R168A (7, Figure 5-2).

l) Adjust the Signal Generator output level to produce an "on-scale" reading on the front panel meter.

m) Using the insulated tuning tool, adjust the slugs in transformers T140 through T142, and T147 (8 through 11, Figure 5-2), to obtain maximum indication on the front panel meter.

NOTE

Monitor the Signal Generator frequency on the counter, maintaining it at 455 kHz; reduce the output level as required to maintain an "on-scale" reading on the meter; a "full-scale" panel meter reading will be obtained with approximately 300 to 400 microvolts input.

5.14 DYNAMIC RANGE ADJUSTMENT

Following completion of the Main IF Amplifier alignment (Paragraph 5-13), the dynamic range should be adjusted as follows:

a) Leave the test equipment in the same configuration as at the completion of step "m", Paragraph 5-13.

b) Connect the Ballantine VTVM to the IF OUTPUT receptacle, J120.

NOTE

Do not use a terminating load.

c) Adjust the Signal Generator output level to produce a "full-scale" reading on the front panel meter, and record the indication on the VTVM.

d) Set the AGC switch to the OFF position and readjust the Signal Generator output level to produce a "full-scale" reading on the front panel meter. Again record the indication on the VTVM; this should be the same as recorded in step "c" (AGC ON).

e) Increase the Signal Generator output level ten (10) times, and record the indication on the VTVM.

f) Adjust the "Dynamic Range" potentiometer, R187 (4, Figure 5-2), in a clockwise direction until the VTVM indication is exactly nine (9) times the value recorded in step "e".

5.15 IF PREAMPLIFIER ALIGNMENT

The IF Preamplifier, Z113, is aligned as follows:

POWER switch	To ON position
FUNCTION switch	To QP position
ATTENUATOR switch	To 0 dB position
AGC switch	To ON position

METER switch	To FAST position
BAND WIDTH switch	To NARROW position
CAL control	Full clockwise
AUDIO control	Full counter-clockwise
BAND switch	To any position
TUNING control	To any position

b) Connect the Electronic Counter to the high level output of the Signal Generator and connect the adjustable 50-ohm output level to Pin E3 of the IF preamplifier (12, Figure 5-2).

c) Adjust the Signal Generator frequency to 455 kHz ± 35 Hz (as indicated on the Electronic Counter) and set the output level to produce an "on-scale" reading on the front panel meter.

d) Using the insulated tuning tool, adjust the slug in transformer T114 (13, Figure 5-2) to obtain maximum indication on the front panel meter; decreasing the signal level if required to maintain an "on-scale" reading.

e) Using the insulated tuning tool, adjust the slugs in transformers T112 and T113 (14, 15, Figure 5-2) to obtain maximum indication on signal level if required to maintain an "on-scale" reading.

f) Using the insulated tuning tool, adjust the slug in transformer T111 (16, Figure 5-2) to obtain maximum indication on the front panel meter. Alternately re-peak transformers T112 and T113; decreasing the signal level if required to maintain an "on-scale" reading.

g) Note the meter indication, and set the BAND WIDTH switch to the BROAD position without changing the Signal Generator output level. The meter indication should be equal to that obtained in the NARROW position; if not, adjust potentiometer R155 (17, Figure 5-2) to obtain equal meter indications in both positions of the BAND WIDTH switch.

NOTE

Potentiometer R155 affects the IF Preamplifier gain only in the NARROW bandwidth. Full-scale meter indication will be obtained in both BAND WIDTH switch positions with an input of approximately 10 microvolts.

h) Reconnect the RF Tuner output at receptacle J114.

5.16 RF TUNER

The RF Tuner, A101, has been carefully aligned at the factory for optimum performance. Although the alignment procedures are conventional, they must be performed correctly. Do not attempt RF realignment unless absolutely necessary, as when certain critical components may have been replaced. To determine if the RF Tuner requires realignment, proceed as follows:

a) Set up the equipment in a normal operating configuration, as described in Section II, Paragraphs 2-11 through 2-13.

b) Set the FUNCTION switch to the CAL position, and adjust the CAL control to obtain a convenient indication on the front panel meter.

c) Starting with the BAND 1 position, carefully tune the RFI Meter from the low to the high end of each band, noting the response on the panel meter.

d) If the response in step "c" differs by more than 3 dB within a particular band, realignment of that band is indicated.

5.17 RF TUNER ALIGNMENT

The RF Tuner, A101, is aligned as follows:

a) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To QP position

ATTENUATOR switch	To 0 dB position
CAL control	To mid position
AUDIO control	Full counter-clockwise
AGC switch	To ON position
BAND WIDTH switch	To NARROW position
METER switch	To FAST position
BAND switch	To band to be aligned
TUNING control	To middle of band to be aligned

b) Connect the 50-ohm output of the Signal Generator to the RF INPUT receptacle, J101, and the high level output to the Electronic Counter; adjust the output level to 30 microvolts.

c) Tune the Signal Generator frequency for maximum indication on the panel meter, adjusting the output level if required to maintain an "on-scale" reading.

d) Using the insulated tuning tool, adjust the slug in the mixer transformer, T109 (1, Figure 5-3) to obtain maximum indication on the front panel meter; decreasing the signal level if required to maintain an "on-scale" reading.

NOTE

Do not remove the shield plates around the RF Tuner assembly, all adjustments are made from the top.

e) Adjust the Signal Generator frequency to exactly 10 kHz (as indicated on the Electronic Counter) and adjust the output level to 100 microvolts. Set the RFI Meter BAND switch to the BAND 1 position and adjust the TUNING control for maximum indication on the front panel meter. Read the frequency on the dial. If it deviates more than a half division from 10 kHz, reset the RFI Meter TUNING to exactly 10 kHz and adjust oscillator trimmer capacitor C132 (2, Figure 5-3) to obtain maximum meter indication.

KEY TO FIGURE 5-3

INDEX NO.	REF. DESIG	FUNCTION	PARA. REF.
1	T109	Slug adjustment, mixer peaking	5-17, "d"
2	C132	Band 1; 10 kHz tracking	5-17, "e"
3	C140	Band 1; 22.5 kHz tracking	5-17, "f"
4	C130	Band 2; 22.5 kHz tracking	5-17, "g"
5	C138	Band 2; 50 kHz tracking	5-17, "g"
6	C128	Band 3; 50 kHz tracking	5-17, "h"
7	C136	Band 3; 112 kHz tracking	5-17, "h"
8	C126	Band 4; 112 kHz tracking	5-17, "i"
9	C134	Band 4; 250 kHz tracking	5-17, "i"
10	T101	Band 1; 10 kHz RF peaking	5-17, "j"
11	T102	Band 1; 10 kHz RF peaking	5-17, "j"
12	C106	Band 1; 22.5 kHz RF peaking	5-17, "k"
13	T103	Band 2; 22.5 kHz RF peaking	5-17, "l"
14	T104	Band 2; 22.5 kHz RF peaking	5-17, "l"
15	C107	Band 2; 50 kHz RF peaking	5-17, "l"
16	T105	Band 3; 50 kHz RF peaking	5-17, "m"
17	T106	Band 3; 50 kHz RF peaking	5-17, "m"
18	C110	Band 3; 112 kHz RF peaking	5-17, "m"
19	T107	Band 4; 112 kHz RF peaking	5-17, "n"
20	T108	Band 4; 112 kHz RF peaking	5-17, "n"
21	C111	Band 4; 250 kHz RF peaking	5-17, "n"
22	T110	Slug adjustment, local oscillator	

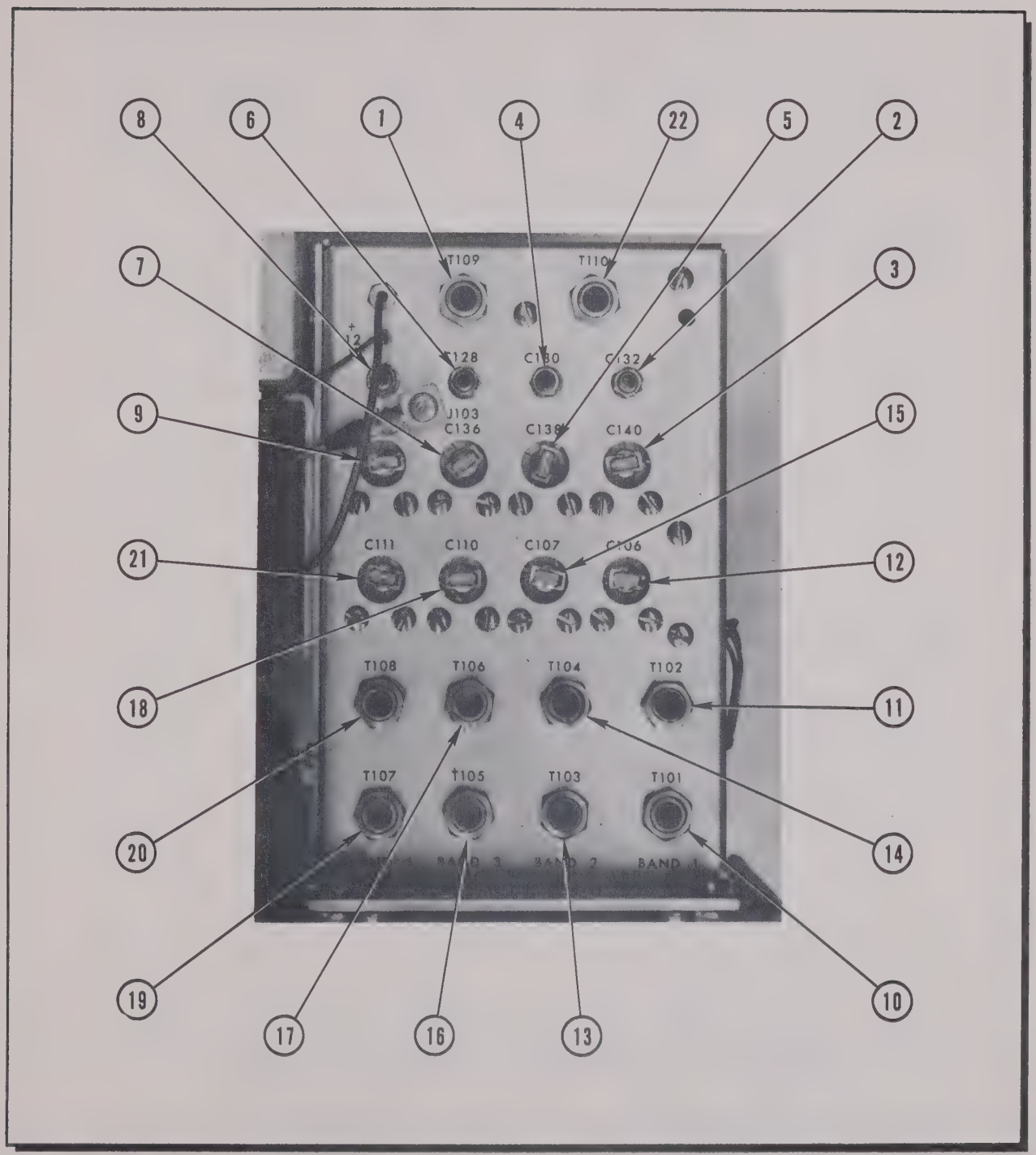


Figure 5-3. RF Tuner Alignment Adjustments

f) Repeat step "e" at 22.5 kHz, on Band 1 adjusting oscillator trimmer capacitor C140 (3, Figure 5-3) to correct any dial deviation. Alternately repeak C132 and C140 until proper frequency tracking is achieved.

g) Repeat steps "e" and "f" for BAND 2, tuning the Signal Generator and RFI Meter to 22.5 and 50 kHz respectively, and adjusting capacitors C130 and C138 (4, 5, Figure 5-3) if required.

h) Repeat steps "e" and "f" for BAND 3, tuning the Signal generator and RFI Meter to 50 and 112 kHz respectively, and adjusting capacitors C128 and C136 (6, 7, Figure 5-3) if required.

i) Repeat steps "e" and "f" for BAND 4, tuning the Signal Generator and RFI Meter to 112 and 250 kHz respectively, and adjusting capacitors C126 and C134 (8, 9, Figure 5-3) if required.

j) Set the BAND switch to the BAND 1 position and TUNING control to 10 kHz. Tune the Signal Generator for maximum indication on the front panel meter. Using the insulated tuning tool, adjust the slug in RF transformers T101 and T102 (10, 11, Figure 5-3) to obtain maximum meter indication.

CAUTION

The tuning of the RF circuits is fairly broad. Do not touch them unless absolutely necessary, as improper adjustment will cause deterioration of the input VSWR of the RFI Meter.

k) Repeat step "j" at 22.5 kHz and adjust RF capacitor C106 (12, Figure 5-3) for maximum meter indication. Alternately repeak T101 and T102 at 10 kHz and C106 at 22.5 kHz until maximum meter indication is achieved.

l) Repeat steps "j" and "k" for BAND 2, tuning the Signal Generator and RFI Meter to 22.5 and 50 kHz respectively, and adjusting transformers T103 and T104, and capacitor C107 (13, 14, 15, Figure 5-3), if required.

m) Repeat steps "j" and "k" for BAND 3, tuning the Signal Generator and RFI Meter to 50 and 112 kHz respectively, and adjusting transformers T105 and T106, and capacitor C110 (16, 17, 18, Figure 5-3), if required.

n) Repeat steps "j" and "k" for BAND 4, tuning the Signal Generator and RFI Meter to 112 and 250 kHz respectively, and adjusting transformers T107 and T108, and capacitor C111 (19, 20, 21, Figure 5-3), if required.

5.18 METER SCALE TRACKING

The front panel meter is "tracked" by aligning the AGC loop transfer characteristics curve at the 1, 10, and 100 points on the logarithmic meter scale.

5.19 TRACKING ADJUSTMENTS

The "tracking" adjustments are performed sequentially in the FI, QP, and PEAK positions of the FUNCTION switch. A CW type signal is used, producing an identical IF output for the three (3) positions of the FUNCTION switch. The meter is then adjusted to provide identical readings for each of the positions. The detector weighting circuits then provide a meter reading proportional to the RMS value of the IF signal. The meter scale tracking is adjusted as follows:

a) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To FI position
ATTENUATOR switch	To 0 dB position
AGC switch	To ON position
METER switch	To FAST position
BAND WIDTH switch	To NARROW position
AUDIO control	Full counter-clockwise
BAND switch	To BAND 4 position
TUNING control	To 160 kHz

NOTE

The shield plate must be in place, covering the IF section.

b) Connect the 50-ohm output of the Signal Generator to the RF INPUT receptacle, J101, and adjust the output level for a signal of 10 microvolts at a frequency of 160 kHz; peak the tuning as required to obtain maximum indication on the front panel meter.

c) Adjust the CAL control as required to provide a "half-scale" (10 microvolts, or 20 dB) indication on the panel meter.

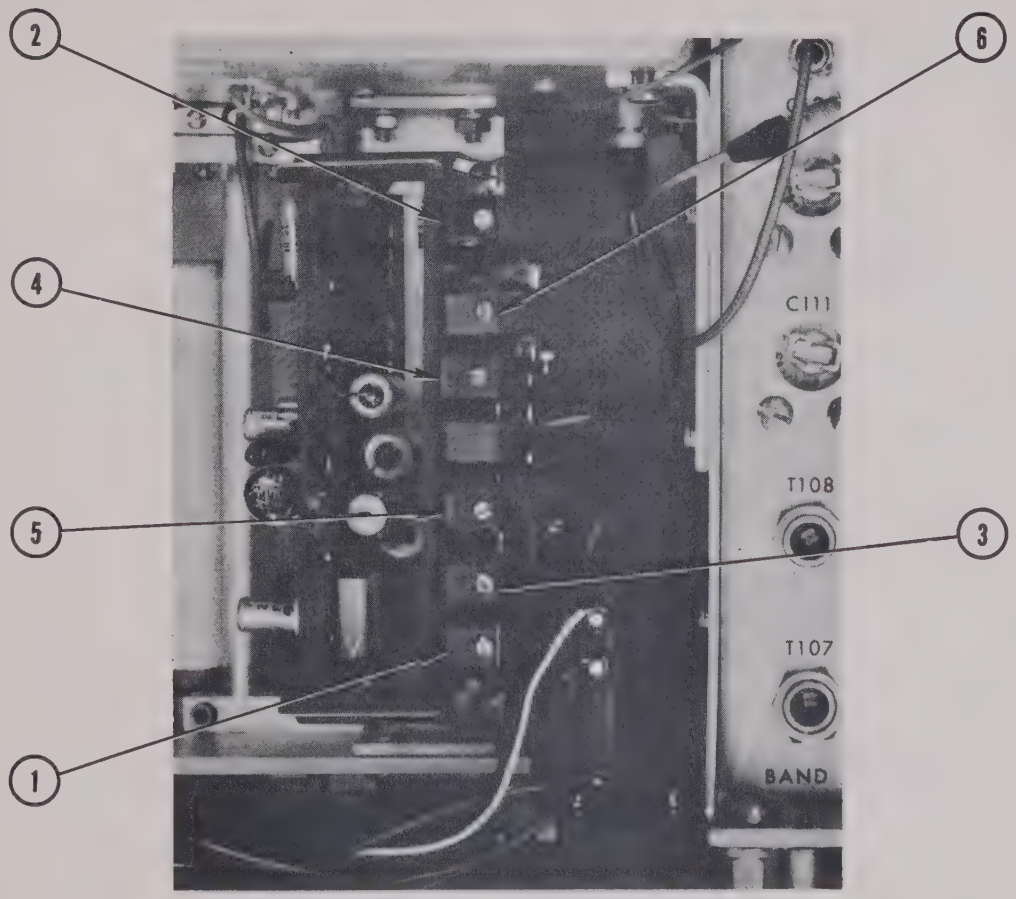
d) Decrease the Signal Generator output level to 1.0 microvolt and check that the panel meter indicates 1.0 microvolt (0 dB); if not, adjust the FI-1 potentiometer, R211 (1, Figure 5-4), until this indication is obtained.

e) Increase the Signal Generator output level to 100 microvolts and check that the panel meter indicates 100 microvolts (40 dB); if not, adjust the "Log Range" potentiometer, R226 (2, Figure 5-4), until this indication is obtained.

f) Decrease the Signal Generator output level to 10 microvolts and check that the panel meter indicates 10 microvolts (20 dB); if required, adjust the CAL control until this indication is obtained.

g) Repeat steps "d" through "f" until the panel meter tracking at the 1, 10, and 100 microvolt (0, 20, and 40 dB) points agrees with the Signal Generator outputs of 1, 10, and 100 microvolts respectively.

h) Insert a Step Attenuator (Hewlett-Packard Model 355B or D) in series with the Signal Generator Output; set the Attenuator to zero, the Signal Generator output level to 100 microvolts, and adjust the CAL control to obtain a "full-scale" (100 microvolts, or 40 dB) indication on the front panel meter.



KEY TO FIGURE 5-4

INDEX NO.	REF. DESIG	FUNCTION	PARA. REF.
1	R211	FI-1 potentiometer	5-19, "d"
2	R226	LOG RANGE potentiometer	5-19, "e"
3	R210	QP-1 potentiometer	5-19, "j"
4	R207	QP-100 potentiometer	5-19, "k"
5	R218	PK-1 potentiometer	5-19, "o"
6	R206	PK-100 potentiometer	5-19, "p"

Figure 5-4. Meter Scale Tracking Potentiometer Adjustments

i) Vary the Attenuator in 10 dB steps and check that the panel meter does track properly; if not, repeat steps "b" through "f" until proper tracking is obtained.

CAUTION

Do not adjust the CAL control or "Log Range" potentiometer, R226, during the subsequent steps.

j) Set the FUNCTION switch to the QP position, the Attenuator to zero, and adjust the Signal Generator output level to 1.0 microvolt. Check that the panel meter indicates 1.0 microvolt (0 dB); if not, adjust the QP-1 potentiometer, R210 (3, Figure 5-4), until this indication is obtained.

k) Increase the Signal Generator output level to 100 microvolts and check that the panel meter indicates 100 microvolts (40 dB); if not, adjust the QP-100 potentiometer, R207 (4, Figure 5-4), until this indication is obtained.

l) Repeat steps "j" and "k" until the panel meter tracking at the 1 and 100 microvolt (0 and 40 dB) points agrees with the Signal Generator outputs of 1 and 100 microvolts respectively.

m) Vary the Attenuator in 10 dB steps and check that the panel meter does track properly; if not, repeat steps "j" through l" until proper tracking is obtained.

n) Set the FUNCTION switch to the PEAK position, the Attenuator to zero, and adjust the Signal Generator output level to 1.0 microvolt.

o) Adjust the PEAK control until the white bar on the PEAK indicator is centered (vertical) and check that the panel meter indicates 1 to 2 dB; if not, adjust the PK-1 potentiometer, R218 (5, Figure 5-4), until this indication is obtained.

NOTE

Interaction occurs between the PEAK control and PK-100 potentiometer adjustments. These two should be adjusted together until the desired panel meter reading is obtained.

p) Increase the Signal Generator output level to 100 microvolts and check that the white bar on the PEAK indicator is centered; if not, adjust the PK-100 potentiometer, R206 (6, Figure 5-4), until this indication is obtained.

NOTE

Interaction occurs between the PEAK control and PK-100 potentiometer adjustments. These two should be adjusted together until the desired panel meter reading is obtained.

q) Vary the Attenuator in 10 dB steps and check that the panel meter does track properly; if not, repeat steps "n" through "p" until proper tracking is obtained.

5.20 REMOTE METER ADJUSTMENT

When a Remote Meter (STODDART Model 90078-13) is connected to the Y-OUTPUT receptacle, J121, its internal resistance must be adjusted to match that of R240. This is to provide the same panel meter indication with, or without, the Remote Meter connected. This adjustment is made after the meter scale tracking adjustments of Paragraph 5.19, and is performed as follows:

a) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To FI position
ATTENUATOR switch	To +20 dB position

AGC switch	To ON position
METER switch	To FAST position
AUDIO control	Full counter-clockwise
BAND switch	To any position
TUNING control	To any position

b) Connect the 50-ohm output of the Signal Generator to the RF INPUT receptacle, J101; adjust the output level to 100 microvolts.

c) Tune the RFI Meter and Signal Generator to exactly the same frequency, and adjust the CAL control to provide a "full-scale" (100 microvolts) indication on the panel meter.

d) Connect the Remote Meter to the Y-OUTPUT receptacle, and adjust potentiometer R239 until the meter readings are equal; with, or without, the Remote Meter connected.

NOTE

Potentiometer R239 is located on the rear of the sub-panel assembly, above, and slightly behind the AGC switch.

5.21 CAL FIGURE

Following alignment, the CAL (calibration) figure must be measured for both NARROW and BROAD bandwidth switch positions. These figures are then recorded on the Calibration Chart Set, and used to standardize the gain at the measurement frequency.

5.22 NARROW BAND CAL FIGURE

Measure the narrow band (NB) cal figure as follows:

a) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To FI position
ATTENUATOR switch	To +20 dB position

AUDIO control	Full counter-clockwise
AGC switch	To ON position
METER switch	To SLOW position
BANDWIDTH switch	To NARROW position
BAND switch	To BAND 1 position
TUNING control	To 10 kHz

b) Connect the 50-ohm output of the Signal Generator to the RF INPUT receptacle, J101, and adjust the output level for a signal of 100 microvolts at a frequency of 10 kHz; adjust the CAL control to provide a "half-scale" (10 microvolts, or 20 dB) indication on the panel meter.

c) Set the FUNCTION switch to the CAL position and record the panel meter indication (in dB) as the 10 kHz NB cal figure.

d) Set the FUNCTION switch to the FI position and repeat steps "b" and "c" at 16.5 and 22.5 kHz respectively; average the three readings and record the result as the BAND 1 NB cal figure on the Calibration Chart Set.

e) Set the BAND switch to the BAND 2 position, FUNCTION switch to FI, and repeat steps "b" through "d" at 22.5, 36, and 50 kHz respectively; record the result as the BAND 2 NB cal figure on the Calibration Chart Set.

f) Set the BAND switch to the BAND 3 position, FUNCTION switch to FI, and repeat steps "b" through "d" at 50, 80, and 112 kHz respectively; record the result as the BAND 3 NB cal figure on the Calibration Chart Set.

g) Set the BAND switch to the BAND 4 position, FUNCTION switch to FI, and repeat steps "b" through "d" at 112, 180, and 250 kHz respectively; record the result as the BAND 4 NB cal figure on the Calibration Chart Set.

5.23 BROAD BAND CAL FIGURE

Measure the broad band (BB) cal figure as follows:

a) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To PEAK position
ATTENUATOR switch	To +20 dB position
AUDIO control	Full counter-clockwise
AGC switch	To ON position
METER switch	To SLOW position
BAND WIDTH switch	To BROAD position
BAND switch	To BAND 1 position
TUNING control	To 10 kHz

b) Connect the output of the Impulse Generator (STODDART Model 93453-1, or 91263-1) to the RF INPUT receptacle, J101, and adjust the output level to 100 dB at 60 PPS; adjust the PEAK control to provide a "full-scale" (100 microvolts, or 40 dB) indication on the panel meter.

c) Adjust the CAL control until the white bar on the PEAK indicator is centered (vertical); set the FUNCTION switch to the CAL position and record the panel meter indication (in dB) as the 10 kHz BB cal figure on the Calibration Chart Set.

d) Set the FUNCTION switch to the PEAK position and repeat steps "b" and "c" at 16.5 and 22.5 kHz respectively; average the three readings and record the result as the BAND 1 BB cal figure on the Calibration Chart Set.

e) Set the BAND switch to the BAND 2 position, FUNCTION switch to PEAK, and repeat steps "b" through "d" at 22.5, 36, and 50 kHz respectively; record the result as the BAND 2 BB cal figure on the Calibration Chart Set.

f) Set the BAND switch to the BAND 3 position, FUNCTION switch to PEAK, and repeat steps "b" through "d" at 50, 80, and 112 kHz respectively; record the result as the BAND 3 BB cal figure on the Calibration Chart Set.

g) Set the BAND switch to the BAND 4 position, FUNCTION switch to PEAK, and repeat steps "b" through "d" at 112, 180, and 250 kHz respectively; record the result as the BAND 4 BB cal figure on the Calibration Chart Set.

5.24 IMPULSE TRACKING

The impulse tracking should be checked as follows:

a) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To PEAK position
ATTENUATOR switch	To 0 dB position
AGC switch	To ON position
METER switch	To FAST position
BAND WIDTH switch	To BROAD position
AUDIO control	Full counter-clockwise
BAND switch	To BAND 4 position
TUNING control	To 250 kHz

b) Connect the output of the Impulse Generator (STODDART Model 93453-1, or 91263-1) to the RF INPUT receptacle, J101, and adjust the output level to 80 dB at 60 PPS.

c) Adjust the PEAK control to obtain a "half-scale" (10 microvolts, or 20 dB) indication on the panel meter, and adjust the CAL control to obtain a "null" on the PEAK indicator (as evidenced by minimum equal oscillation through the vertical index markers).

d) Decrease the Impulse Generator output level by 10 dB, readjust the PEAK control to obtain a "null" on the PEAK indicator as in step "c"; check that the panel meter indicates 10, $\pm$ 1 dB.

e) Decrease the Impulse Generator output level by a further 10 dB, readjusting the PEAK control to obtain a "null" on the PEAK indicator as in step "c"; check that the panel meter indicates 0, +2, -0 dB.

f) Increase the Impulse Generator output level to 80 dB and repeat step "c".

g) Increase the Impulse Generator output level by 10 dB, readjusting the PEAK control to obtain a "null" on the PEAK indicator as in step "c"; check that the panel meter indicates 30, $\pm$ 1 dB.

h) Increase the Impulse Generator output level by a further 10 dB, readjusting the PEAK control to obtain a "null" on the PEAK indicator as in step "c"; check that the panel meter indicates 40, $\pm$ 1 dB.

5.25 RECOMMENDED SERVICING PROCEDURES

5.26 GENERAL PRECAUTIONS

Observe the following general precautions while trouble-shooting, or replacing components within the RFI Meter:

a) Use extreme care in unsoldering solid-state components, small capacitors, or resistors.

b) Do not use a soldering iron rated at more than 37 watts: Do not apply heat to the connection for more than a few seconds at a time.

c) Do not excessively bend or twist leads of transistors, diodes, or small capacitors and resistors; they break easily.

d) Do not apply any DC potentials to input terminals.

e) Do not reverse battery connections; serious damage will result.

5.27 PRINTED CIRCUIT BOARDS

Printed circuit boards consist of an insulating base (lamination), conductors (foil), feedthrough couplings, and components. The lamination is the structural part of the circuit board, and supports and positions the components. As most laminations are thin, 1/16-inch or less, they are very fragile and must be handled with care.

5.28 The first step in servicing a printed circuit board is to examine the board carefully with a strong magnifying glass. Such an examination may reveal physical damage to the lamination, foil, components, or leads.

5.29 Should examination reveal a broken foil, it is usually more practical to repair the foil than to replace the entire circuit board. If the break is large, place a short length of copper wire across the break and solder the ends to the broken foil. If the break is small, try flowing solder across the break. Do not apply excessive heat, or allow solder to flow to other parts of the foil.

5.30 REMOVAL OF WIRES OR COMPONENTS

When removing wires or components from a printed circuit board, observe the following precautions:

a) Use a soldering aid for manipulating wires.
b) Use heatsinks to protect nearby parts.
c) Heat connections only until wires loosen.
d) Remove wires quickly (but carefully).
e) Remove excess solder before it hardens.

5.31 INSTALLATION OR MOUNTING OF COMPONENTS

When installing or mounting components on a printed circuit board, observe the following precautions:

a) Inspect the board to verify that it is clean and dry.

b) Install heatsinks to protect components.

c) Trim component leads to the approximate length required.

d) Place the components in the correct mounting position.

e) Insert the component leads through the mounting holes in the board (or wrap the leads around mounting terminals)

f) Solder the leads in place. Use sufficient heat to assure a good soldering joint, but be careful to avoid excessive heat.

g) Trim the leads close to the solder joint on the other side of the board.

h) Clean excess solder and resin from all connections.

i) Remove heatsinks.

5.32 TRANSISTOR TESTING

5.33 PREFERRED METHOD

If it is suspected that a particular transistor is defective, either check the transistor in a commercial transistor tester, or replace it with one of known quality.

5.34 OHMMETER METHOD

If neither a transistor tester nor replacement transistor is available, the suspected transistor may be given a simple test with an ohmmeter, as follows:

CAUTION

The ohmmeter must not have a higher potential than 4.5 volts DC, or damage may occur.

a) In checking a transistor with an ohmmeter, the transistor is treated as two separate semiconductor diodes having a common junction. In a good transistor, the diodes will have different forward and inverse resistances, depending upon the polarity of the DC voltage applied by the ohmmeter. When the anode of the diode is made positive with respect to the cathode, the forward resistance should be low. Conversely, when the anode is made negative with respect to the cathode, the inverse resistance should be high.

b) The greater the ratio of the inverse resistance to the forward resistance, the better the transistor. This ratio should be at least 10:1 or greater, in high quality, low-leakage transistors. A transistor is defective, and must be replaced if the forward resistance of either diode is high, if the inverse resistance of either diode is low, or if the ratio of the inverse resistance to the forward resistance is significantly lower than 10:1.

ACCESSORIES

SYMBOL	DESCRIPTION
C601	CAPACITOR, FIXED FILM: 0.012 μf, ±5%, 80 vdcw Sprague No. 192P1235R8 Stoddart No. 12293-123
C602	CAPACITOR, FIXED FILM: 0.027 μf, ±5%, 80 vdcw Sprague No. 192P2735R8 Stoddart No. 12293-273
C603	CAPACITOR, FIXED FILM: 0.056 μf, ±5%, 80 vdcw Sprague No. 192P5635R8 Stoddart No. 12293-563
C604	CAPACITOR, FIXED FILM: 0.12 μf, ±5%, 80 vdcw Sprague No. 192P1245R8 Stoddart No. 12293-124
CP401	ADAPTER, COAXIAL CONNECTOR: Type UG-201A/U; J407 at one end, P406 at other end Stoddart No. 11663
E401	METER, REMOTE: Consists of M401 meter and P408 receptacle Stoddart No. 90078-13
E402	Not used
E403	Not used
E404	ANTENNA LOOP Consists of insulated loop and connector J410
E405	Not used
E406	PROBE, RF CURRENT: Consists of a secondary winding and J414 enclosed in an electrostatic shield Stoddart No. 91550-1
E501	ROD ANTENNA COUPLER: Consists of a Band Switch S501 and four (4) matching impedance transformers, T501 through T504 Stoddart No. 92943-1

SYMBOL	DESCRIPTION
E601	LOOP ANTENNA AND COUPLER: Consists of collapsible loop, single-turn, diamond configuration of coaxial cable. The Loop Antenna Coupler consists of a Band Switch, S601, and four (4) impedance matching networks, T601 and coupling capacitors C601 through C604 Stoddart No. 92938-1
J501	CONNECTOR RECEPTACLE: Input connector, MIL type UG-422/U Stoddart No. 90747-1
J502	CONNECTOR RECEPTACLE: Output connector, MIL type UG-1094/U Stoddart No. 12019
J601	CONNECTOR RECEPTACLE: Part of W601 cable; one each end of cable Automatic Metals No. RF100-B1600 Stoddart No. 18451
P601	Same as J502
P602	Same as J502
P603	Same as J502
S501	SWITCH, ROTARY: Band Switch, Rod Antenna Coupler Stoddart No. 18560
S601	SWITCH, ROTARY: Band Switch, Loop Antenna Coupler Stoddart No. 12295
T501	TRANSFORMER, RF: 10-30 kHz Stoddart No. 94039-1
T502	TRANSFORMER, RF: 20-60 kHz Stoddart No. 94039-2
T503	TRANSFORMER, RF 40-120 kHz Stoddart No. 94039-3

SYMBOL	DESCRIPTION
T504	TRANSFORMER, RF: 80-250 kHz Stoddart No. 94039-4
T601	TRANSFORMER, RF: Impedance Matching Stoddart No. 94418-1
W401	Not used
W402	CABLE ASSEMBLY, POWER: Consists of P403 and J402 Stoddart No. 91258-1
W403	CABLE, ASSEMBLY, RF: Consists of P401 and P402 Stoddart No. 92191-1
W404	CABLE ASSEMBLY, RF: Oscilloscope cable Stoddart No. 90071-1
W405	CABLE ASSEMBLY, RF: Headphone extension cable Stoddart No. 90074-1
W406	Not used
W407	CABLE ASSEMBLY, RF: "Y" output cable Stoddart No. 90075-4
W408	CABLE ASSEMBLY, RF: Remote meter cable Stoddart No. 90075-2

SYMBOL	DESCRIPTION
C101 thru C105	Not used
C106	CAPACITOR, VARIABLE, CERAMIC: 7-45 pf, 500 VDCW MIL-C-81, Type CV11D450 Stoddart No. 10457
C107	Same as C106
C108	CAPACITOR, FIXED, MICA 10 pf, ±5%, MIL Type CM05 ARCO Electronics No. DM15C1000 Stoddart No. 11308-100
C109	CAPACITOR, VARIABLE: AIR DIELECTRIC 2 Sections, 525 pf per section Radio Condenser Co., Div of TRW Stoddart No. 18555
C110	Same as C106
C111	Same as C106
C112	CAPACITOR, FIXED, ELECTROLYTIC: 1 mfd ±20% 35 VDCW Sprague Type 150D105X0035A2 Stoddart No. 11782
C113	Same as C112
C114	CAPACITOR, FIXED, ELECTROLYTIC: 22 mfd, ±20% 15 VDCW Sprague Electric Co. No. 150D226X0015B2 Stoddart No. 18387
C115	Same as C114
C116	CAPACITOR, FIXED, MICA: 30 pf ±5% Type DM 15 ARCO Electronics No. DM15E300J Stoddart No. 11308-300
C117	Same as C112
C118	Same as C112
C119	CAPACITOR, FIXED, MICA: 4700 pf ±5% Type DM-19 ARCO Electronics No. DM-19-472J Stoddart No. 18389-472
C120	CAPACITOR, FIXED, MICA: 2000 pf ±5% Type DM19 ARCO Electronics No. DM19F202J Stoddart No. 18389-202
C121	Not used
C122	CAPACITOR, FIXED, PLASTIC: 0.022 mfd ±10% 250 VDCW Amperex No. C-280AE/A22K Stoddart No. 18394-223
C123	Same as C122
C124	CAPACITOR, FIXED, PLASTIC: 0.47 mfd ±10% 250 VDCW Amperex No. C-280AE/A47K Stoddart No. 18394-474

SYMBOL	DESCRIPTION
C125	CAPACITOR, FIXED, CERAMIC 75 pf, ±2%, MIL Type CC32 Centralab No. TCZ-75 Stoddart No. 11386-750
C126	CAPACITOR, VARIABLE: 0.8 to 18 pf, 750 VDCW JFD Electronics, Type Piston Trimmer No. VC23G Stoddart No. 18396
C127	CAPACITOR, FIXED, CERAMIC 82 pf, ±2%, MIL Type CC32 Centralab No. TCZ-82 Stoddart No. 11386-820
C128	Same as C126
C129	CAPACITOR, FIXED, CERAMIC 100 pf, ±2%, MIL Type CC32 Centralab No. TCZ-100 Stoddart No. 11386-101
C130	Same as C126
C131	CAPACITOR, FIXED, CERAMIC 91 pf, ±2%, MIL Type CC32 Centralab No. TCZ-91 Stoddart No. 11386-910
C132	Same as C126
C133	CAPACITOR, FIXED, CERAMIC 56 pf, ±2%, MIL Type CC25 Centralab No. TCZ-56 Stoddart No. 11386-560
C134	Same as C106
C135	CAPACITOR, FIXED, CERAMIC 30 pf, ±2%, MIL Type CC25 Centralab No. TCZ-30 Stoddart No. 11386-300
C136	Same as C106
C137	CAPACITOR, FIXED, CERAMIC 20 pf, ±2%, MIL Type CC20 Centralab No. TCZ-20 Stoddart No. 11386-200
C138	Same as C106
C139	CAPACITOR, FIXED, CERAMIC 43 pf, ±2%, MIL Type CC25 Centralab No. TCZ-43 Stoddart No. 11386-430
C140	Same as C106
C141	CAPACITOR, FIXED, CERAMIC 62 pf, ±2%, MIL Type CC32 Centralab No. 11386-620
C142	Same as C139
C143	CAPACITOR, FIXED, CERAMIC 39 pf, ±2%, MIL Type CC25 Centralab No. TCZ-39 Stoddart No. 11386-320
C144	Same as C131

SYMBOL	DESCRIPTION
C145	CAPACITOR, FIXED, CERAMIC 110 pf, ±2%, MIL Type CC35 Centralab No. TCZ-110 Stoddart No. 11386-111
C146	Same as C106
C147	CAPACITOR, FIXED, MICA: 180 pf ±5% Type DM 15 ARCO Electronics No. DM15F181J Stoddart No. 11308-181
C148	CAPACITOR, FIXED, MICA: 150 pf ±5% Type DM 15 ARCO Electronics No. DM15F151J Stoddart No. 11308-151
C149	CAPACITOR, FIXED, CERAMIC 27 pf, ±2%, MIL type CC20 Centralab No. TCN-27 Stoddart No. 11656-270
C150	CAPACITOR, FIXED, CERAMIC 5 pf, ±0.5 pf tol., MIL Type CC20 Centralab No. TCN-5 Stoddart No. 11656-050
C151	Same as C150
C152	CAPACITOR, FIXED, CERAMIC 220 pf, ±5%, MIL Type CC45 Centralab No. TCZ-220 Stoddart No. 11386-221
C153	CAPACITOR, FIXED, MICA: Selected value - parallel with C147 May or may not be used.
C154	CAPACITOR, FIXED, FILM 0.01 mfd, ±5%, 80 vdcw Sprague No. 192P1035R8 Stoddart No. 12293-103
C155	CAPACITOR, FIXED, FILM 0.012 mfd, ±5%, 80 vdcw Sprague No. 192P1235R8 Stoddart No. 12293-123
C156	CAPACITOR, FIXED, FILM 0.015 mfd, ±5%, 80 vdcw Sprague No. 192P1535R8 Stoddart No. 12293-153
C157	Not used.
C158	CAPACITOR, FIXED, MICA 1500 pf, ±5%, MIL Type CM06 Cornell Dubilier No. CD19F152J Stoddart No. 11643-152
C159	CAPACITOR, FIXED, MICA 1000 pf, ±1%, MIL Type CM06F102F Arco Electronics, DM15F102F Stoddart No. 11643-102
C160	CAPACITOR, FIXED, PLASTIC: 0.82 mfd ±10% 250 VDCW Amperex No. C-280AE/A82K Stoddart No. 18394-823
C161	Same as C160
C162	Same as C114
C163	Same as C155
C164	Same as C154
C165 thru C185	Not used
C186	CAPACITOR, FIXED, PLASTIC: 0.1 mfd ±10% 250 VDCW Amperex No. C280AE/A100K Stoddart No. 18394-104
C187	CAPACITOR, FIXED, MICA: 270 pf ±2% Type DM 15 ARCO Electronics No. DM15F271J Stoddart No. 11655-271
C188	CAPACITOR, FIXED, FILM: 0.068 mfd ±5% 80 VDCW Sprague Type 192P6835R8 Stoddart No. 12293-683
C189	Same as C187
C190	Same as C122
C191	Not used
C192	Same as C186
C193	Same as C186
C194	Same as C186
C195	Same as C135
C196	Same as C112
C197	Same as C187
C198	Same as C122
C199	Same as C187
C200	Same as C186
C201	Same as C186
C202	CAPACITOR, FIXED, MICA: 330 pf ±5% Type DM 15 ARCO Electronics No. DM15F331J Stoddart No. 11308-331
C203	Same as C135
C204	Same as C122
C205	Same as C112
C206	Same as C112
C207	CAPACITOR, FIXED, MICA: 270 pf ±2% Type DM 15 ARCO Electronics No. DM15F271G Stoddart No. 11655-271
C208	CAPACITOR, FIXED, CERAMIC: 0.02 mfd 150 VDCW Disc Centralab No. DDM-203 Stoddart No. 11474

SYMBOL	DESCRIPTION
C209	Same as C112
C210	Same as C207
C211	CAPACITOR, FIXED, MICA: (Factory Selected Value)
C212	Same as C207
C213	Same as C208
C214	Same as C112
C215	CAPACITOR, FIXED, MICA: 2 pf ±0.5 pf Type DM 15 ARCO Electronics Type DM15C020D Stoddart No. 12323-020
C216	Same as C112
C217	CAPACITOR, FIXED, ELECTROLYTIC: 33 mfd ±10% 10 VDCW Sprague No. 150D336X9010B2 Stoddart No. 18613-330
C218	Same as C207
C219	Same as C208
C220	Same as C208
C221	Same as C135
C222	Same as C207
C223	Same as C208
C224	Same as C208
C225	Same as C208
C226	Not used
C227	CAPACITOR, FIXED, MICA: 100 pf ±5% DM 15 ARCO Electronics No. DM15F101J Stoddart No. 11308-101
C228	CAPACITOR, FIXED, MICA: 430 pf ±5% Type DM 15 ARCO Electronics No. DM15F431J Stoddart No. 11308-431
C229	CAPACITOR, FIXED, PLASTIC: 0.022 mfd ±10% 25VDCW Amperex No. C-280AE/A22K Stoddart No. 18394-223
C230	Same as C208
C231	CAPACITOR, FIXED, PAPER: 0.1 mfd ±20% 200 VDCW MIL Type CP05A3-EC-104M Stoddart No. 11013
C232	CAPACITOR, FIXED, ELECTROLYTIC: 330 mfd ±20% 6 VDCW Sprague No. 150D337X0006S2 Stoddart No. 12304
C233	Same as C208
C234	Same as C112
C235	Not used

SYMBOL	DESCRIPTION
C236	Same as C112
C237	CAPACITOR, FIXED, ELECTROLYTIC: 47 mfd ±20% 20 VDCW Sprague No. 150D476X9020R2 Stoddart No. 11555
C238	CAPACITOR, FIXED, MICA: 680 pf ±5% Type DM 15 ARCO Electronics No. DM15F681J Stoddart No. 11308-681
C239	Same as C112
C240	CAPACITOR, FIXED, ELECTROLYTIC: 100 mfd ±20% 10 VDCW Sprague No. 150D107X9010R2 Stoddart No. 11791-101
C241	CAPACITOR, FIXED, MYLAR: 0.0033 mfd ±10% 200 VDCW Electron Products No. M2-332E Stoddart No. 18520
C242	Same as C241
C243	Same as C112
C244	Not used
C245	Same as C208
C246 thru C263	Not used
C264	CAPACITOR, FIXED, ELECTROLYTIC: 10 mfd ±10% 20 VDCW Sprague No. 150D106X9020B2 Stoddart No. 11722
C265	Same as C112
C266	Same as C112
C267	Same as C112
C268	Same as C112
C269	Not used
C270	Same as C217
C271	Not used
C272	Same as C237
C273	Not used
C274	Not used
C275	CAPACITOR, FIXED, ELECTROLYTIC: 150 mfd ±10% 15 VDCW Texas Instruments No. SCM157HP015D2 Stoddart No. 18518-1
C276	Same as C275
C277 thru C280	Not used

SYMBOL	DESCRIPTION
C281	CAPACITOR, FIXED, MICA: 1000 pf ±5% Type DM 15 ARCO Electronics No. DM15F102J Stoddart No. 11308-102
C282	Same as C281
C283	Same as C208
C284	
thru	Not used
C301	
C302	CAPACITOR, FIXED, CERAMIC: 0.01 mfd 1500 VDCW Style 811, Ceramicon Erie Resistor Corp. Stoddart No. 10369
C303	Same as C302
C304	CAPACITOR, FIXED, CERAMIC: 1000 pf Feed-thru Type Allen Bradley Type FB25-102W Stoddart No. 11684
C305	Not used
C306	Same as C302
C307	Same as C302
C308	Same as C304
C309	
thru	Not used
C311	
C312	CAPACITOR, FIXED, ELECTROLYTIC: 82 mfd 50 VDCW Fansteel No. SP-314-20 Stoddart No. 18511
C313	CAPACITOR, FIXED, ELECTROLYTIC: 100 mfd ±10% 25 VDCW MIL-C-3965 Type CL64BG101KP3 Stoddart No. 18512
CR101	SEMICONDUCTOR DEVICE, DIODE: Type 1N459 Stoddart No. 1N459
CR102	Same as CR101
CR103	Same as CR101
CR104	Same as CR101
CR105	SEMICONDUCTOR DEVICE, DIODE: Type 1N498 Stoddart No. 1N498
CR106	SEMICONDUCTOR DEVICE, DIODE: Type 1N627 Stoddart No. 1N627
CR107	Same as CR105
CR108	Same as CR105
CR109	Not used

SYMBOL	DESCRIPTION
CR110	Same as CR105
CR111	Not used
CR112	Same as CR105
CR113	Same as CR105
CR114	Not used
CR115	SEMICONDUCTOR DEVICE, DIODE: Type 1N935A Stoddart No. 1N935A
CR116	SEMICONDUCTOR DEVICE, DIODE: Varicap (Supplied in matched pair) TRW Semiconductors Inc. No. V100 ±20% M2B Stoddart No. 18561
CR117	Same as CR116
CR118	Same as CR116
CR119	Same as CR116
CR120	SEMICONDUCTOR DEVICE, DIODE: Type 1N753A Stoddart No. 1N753A
CR121	
thru	Not used
CR306	
CR307	SEMICONDUCTOR DEVICE, DIODE: Pacific Semiconductor No. PS405 Stoddart No. 18508
CR308	Same as CR307
CR309	Same as CR307
CR310	Same as CR307
CR311	SEMICONDUCTOR DEVICE, DIODE: Type 1N750A Stoddart No. 1N750A
CR312	SEMICONDUCTOR DEVICE, DIODE: Type 1N751A Stoddart No. 1N751A
CR313	SEMICONDUCTOR DEVICE, DIODE: Type 1N759A Stoddart No. 1N759A
CR314	Same as CR312
CR315	SEMICONDUCTOR DEVICE, DIODE: Texas Instruments Type G-130 Stoddart No. 18509
CR316	Same as CR315
CR317	Same as CR307
DL101	DELAY LINE; Technitrol Delay Lines No. C25GTS-1200-50 Stoddart No. 18385

SYMBOL	DESCRIPTION
F301	FUSE, CARTRIDGE: 1/10 Amp, 125 V Littlefuse Inc. No. 3AG Stoddart No. 18528
F302	Same as F301
J101	CONNECTOR, RECEPTACLE: Automatic Metals No. B3800-10 Stoddart No. 12385
J102	Not used
J103	CONNECTOR, RECEPTACLE: Right Angle Connector Microdot Inc. No. 33-42A1-28 Stoddart No. 11634
J104	POST, BINDING: H. H. Eby Co. No. 6604 Stoddart No. 10171
J105 thru J112	Not used
J113	CONNECTOR, RECEPTACLE: 50 Ohms Microdot Inc. No. 31-50 Stoddart No. 11564
J114	Same as J113
J115	Same as J113
J116	Not used
J117	Not used
J118	JACK, TELEPHONE: MIL Type JJ-089 Stoddart No. 18003
J119	CONNECTOR, RECEPTACLE: MIL Type UG-290A/U Stoddart No. 10121
J120	Same as J119
J121	JACK, TELEPHONE: MIL Type 2J-1047A Stoddart No. 10123
J122	Same as J119
J123 thru J300	Not used
J301	CONNECTOR, RECEPTACLE: MIL Type MS3102E-14S-7P Stoddart No. 11180
J302	Not used
J303	Not used
J304	CONNECTOR, RECEPTACLE: 18 Contacts Viking Electronics No. VH18/1AB5 Stoddart No. 18326

SYMBOL	DESCRIPTION
J305	Same as J304
J306	Same as J304
J307	CONNECTOR, RECEPTACLE: 2 contacts Viking Electronics No. VR2/4CE6 Stoddart No. 18325
FL401	CRYSTAL FILTER: 455 kHz Stoddart No. 12270
L101	Not used
L102	INDUCTOR, AUDIO FREQUENCY: 6 Henries United Transformer Corp. No. DOT-26 Stoddart No. 11721
L103	Not used
L104	INDUCTOR, RADIO FREQUENCY: 10 mhy Essex Electronics Corp. Type WEE-DUCTOR No. 10000 Stoddart No. 11719-103
L105	INDUCTOR, RADIO FREQUENCY 12 μhy Stoddart No. 94429-1
L106	INDUCTOR, RADIO FREQUENCY 42.5 μhy Stoddart No. 94429-3
L107	INDUCTOR, RADIO FREQUENCY 35.6 μhy Stoddart No. 94429-2
L108	Same as L105
L109	INDUCTOR, RADIO FREQUENCY: 1.5 mhy Essex Electronics Corp. Type WEE-DUCTOR No. 10000 Stoddart No. 11719-152
L110	Not used
L111	Not used
L112	Same as L104
L113 thru L300	Not used
L301	INDUCTOR, RADIO FREQUENCY: 50 mhy Microtran Co. No. QGL 50-M Stoddart No. 18617-500
L302	Same as L301
L303 thru L404	Not used

SYMBOL	DESCRIPTION
L405	INDUCTOR, RADIO FREQUENCY: 2.2 mhy Essex Electronics type WEE-DUCTOR 10,000 Stoddart No. 11719-22
L406	Same as L405
L407	INDUCTOR, RADIO FREQUENCY: 560 uhy Essex Electronics type WEE-DUCTOR 10,000 Stoddart No. 11719-561
L408	INDUCTOR, RADIO FREQUENCY: 1 mh Essex Electronics type WEE-DUCTOR 10,000 Stoddart No. 11719-102
M101	METER, PANEL: Stoddart No. 18541
M102	METER, BATTERY: Stoddart No. 18543
M103	METER, PEAK: Stoddart No. 18542
P101	CONNECTOR, PLUG: Part of cable assembly W101, listed for reference only
Q101	TRANSISTOR: Type 2N3707 Stoddart No. 2N3707
Q102	Same as Q101
Q103	Same as Q101
Q104	Same as Q101
Q105	Same as Q101
Q106	Same as Q101
Q107	TRANSISTOR: Type 2N384 Stoddart No. 2N384
Q108	Same as Q107
Q109	TRANSISTOR: Type 2N274 Stoddart No. 2N274
Q110	TRANSISTOR: Type 2N1309 Stoddart No. 2N1309
Q111	Same as Q110
Q112	Same as Q110
Q113	Same as Q107
Q114	Not used
Q115	Same as Q101
Q116	Same as Q101
Q117	Not used

SYMBOL	DESCRIPTION
Q118	TRANSISTOR: Type 2N4058 Stoddart No. 2N4058
Q119	Same as Q118
Q120	TRANSISTOR: Type 2N217 Stoddart No. 2N217
Q121	Same as Q120
Q122	TRANSISTOR: Type 2N647 Stoddart No. 2N647
Q123	Same as Q101
Q124	Same as Q101
Q125 thru Q136	Not used
Q137	TRANSISTOR: Type C682 Stoddart No. 18523
Q138	TRANSISTOR: Type 2N3250 Stoddart No. 2N3250
Q139	Same as Q122
Q140 thru Q200	Not used
Q201	TRANSISTOR: Type 2N2552 Stoddart No. 2N2552
Q202	Same as Q201
Q203	Same as Q201
Q204	TRANSISTOR: Type 2N1711 Stoddart No. 2N1711
R101	RESISTOR, FIXED, COMPOSITION: 18 ohms ±5% 1/4 w Allen Bradley Type CB-1805 Stoddart No. 11693-180
R102	RESISTOR, FIXED, COMPOSITION: 270 ohms ±5% 1/4 w Allen Bradley Type CB-2715 Stoddart No. 11693-271
R103	Same as R102
R104	Not used
R105	RESISTOR, FIXED, COMPOSITION 220,000 ohms, ±5%, 1/4 w Allen Bradley Type CB2245 Stoddart No. 11693-224

SYMBOL	DESCRIPTION
R106	Not used
R107	RESISTOR, FIXED COMPOSITION 200,000 ohms, ±5%, 1/4 w Allen Bradley Type CB-2045 Stoddart No. 11693-204
R108	RESISTOR, FIXED, COMPOSITION: 1,000 ohms ±5% 1/4 w Allen Bradley Type CB-1025 Stoddart No. 11693-102
R109	Same as R108
R110	RESISTOR, FIXED, COMPOSITION: 6,800 ohms ±5% 1/4 w Allen Bradley Type CB-6825 Stoddart No. 11693-682
R111	Same as R110
R112	RESISTOR, FIXED, COMPOSITION: 1,200 ohms ±5% 1/4 w Allen Bradley Type CB-1225 Stoddart No. 11693-122
R113	Same as R112
R114	RESISTOR, FIXED, COMPOSITION: 22,000 ohms ±5% 1/4 w Allen Bradley Type CB-2235 Stoddart No. 11693-223
R115	Same as R110
R116	RESISTOR, VARIABLE: 25,000 ohms ±5% 1 w Bourns Inc., Trimpot Div. No. 3280W-66-253 Stoddart No. 18397-253
R117	Same as R110
R118	RESISTOR, FIXED, COMPOSITION: 470 ohms ±5% 1/4 w Allen Bradley Type CB-4715 Stoddart No. 11693-471
R119	RESISTOR, FIXED, COMPOSITION: 5,600 ohms ±5% 1/4 w Allen Bradley Type CB-5625 Stoddart No. 11693-562
R120	Same as R119
R121	Same as R119
R122	RESISTOR, FIXED, COMPOSITION 120,000 ohms, ±5%, 1/4 w Allen Bradley Type CB-1245 Stoddart No. 11623-124
R123	RESISTOR, FIXED, COMPOSITION: 27,000 ohms ±5% 1/4 w Allen Bradley Type CB-2735 Stoddart No. 11693-273
R124	Same as R107
R125	RESISTOR, FIXED, COMPOSITION: 1,500 ohms ±5% 1/4 w Allen Bradley Type CB-1525 Stoddart No. 11693-152
R126	Same as R123

SYMBOL	DESCRIPTION
R127	RESISTOR, FIXED, COMPOSITION: 330 ohms ±5% 1/4 w Allen Bradley Type CB-3315 Stoddart No. 11693-331
R128	Not used
R129	Not used
R130	RESISTOR, FIXED, COMPOSITION: 270,000 ohms ±5% 1/4 w Allen Bradley Type CB-2745 Stoddart No. 11693-274
R131	RESISTOR, FIXED, COMPOSITION: 56 ohms ±5% 1/4 w Allen Bradley Type CB-5605 Stoddart No. 11693-560
R132	Same as R118
R133	RESISTOR, FIXED, COMPOSITION: 51 ohms ±5% 1/4 w Allen Bradley Type CB-5105 Stoddart No. 11693-510
R134	Same as R112
R135	RESISTOR, FIXED, COMPOSITION: 10,000 ohms ±5% 1/4 w Allen Bradley Type CB-1035 Stoddart No. 11693-103
R136	Same as R135
R137	Same as R135
R138	Same as R130
R139	Not used
R140	RESISTOR, FIXED, COMPOSITION: 33 ohms ±5% 1/4 w Allen Bradley Type 3305 Stoddart No. 11693-330
R141	Same as R108
R142	Same as R110
R143	RESISTOR, FIXED, COMPOSITION: 2,700 ohms ±5% 1/4 w Allen Bradley Type CB-2725 Stoddart No. 11693-272
R144	RESISTOR, FIXED, COMPOSITION: 15,000 ohms ±5% 1/4 w Allen Bradley Type CB-1535 Stoddart No. 11693-153
R145	Not used
R146	Same as R108
R147	Same as R144
R148	Same as R143
R149	Same as R108
R150	RESISTOR, FIXED, COMPOSITION: 39 ohms ±5% 1/4 w Allen Bradley Type CB-3905 Stoddart No. 11693-390

SYMBOL	DESCRIPTION
R151	RESISTOR, FIXED, COMPOSITION: 39,000 ohms ±5% 1/4 w Allen Bradley Type CB-3935 Stoddart No. 11693-393
R152	Same as R108
R153	RESISTOR, FIXED, COMPOSITION: 4,700 ohms ±5% 1/4 w Allen Bradley Type CB-4725 Stoddart No. 11693-472
R154	RESISTOR, FIXED, COMPOSITION: 12,000 ohms ±5% 1/4 w Allen Bradley Type CB-1235 Stoddart No. 11693-123
R155	RESISTOR, VARIABLE, COMPOSITION: 1,000 ohms 0.5 w Beckman/Helipot, "Helitrim" Part No. 62PR1K Stoddart No. 18390-102
R156	Same as R108
R157	RESISTOR, FIXED, COMPOSITION: 5,100 ohms ±5% 1/4 w Allen Bradley Type CB-5125 Stoddart No. 11693-512
R158 thru	Not used
R165	
R166	RESISTOR, FIXED, FILM: 50 ohms ±1% 1/2 w Penn Resistor Corp. Type FCA 15 Stoddart No. 10935-50RO
R167	Same as R166
R168A, B	RESISTOR, VARIABLE, COMPOSITION: 2 Section, 1000 ohms/500 ohms Allen Bradley Type B1021,A5011 Stoddart No. 11362
R169	RESISTOR, FIXED, FILM: 62 ohms ±1% 1/2 w Penn Resistor Corp. Type FCA15 Stoddart No. 10935-62RO
R170	RESISTOR, FIXED, FILM: 249 ohms ±1% 1/2 w Penn Resistor Corp. Type FCA15 Stoddart No. 10935-2490
R171	Same as R169
R172	Same as R143
R173	Same as R151
R174	RESISTOR, FIXED, COMPOSITION: 100,000 ohms ±5% 1/4 w Allen Bradley Type CB-1045 Stoddart No. 11693-104
R175	Same as R143
R176	RESISTOR, FIXED, COMPOSITION 82,000 ohms, ±5%, 1/4 w Allen Bradley Type CB-9235 Stoddart No. 11693-823

SYMBOL	DESCRIPTION
R177	Same as R108
R178	RESISTOR, FIXED, COMPOSITION: (Factory selected value) 1/4 w Stoddart No. 11693-( )
R179	Same as R176
R180	Same as R151
R181	RESISTOR, FIXED, COMPOSITION: 3,300 ohms ±5% 1/4 w Allen Bradley Type CB-3325 Stoddart No. 11693-332
R182	Not used
R183	Same as R125
R184	RESISTOR, FIXED, COMPOSITION 8,200 ohms, ±5%, 1/4 w Allen Bradley Type CB-8225 Stoddart No. 11693-822
R185	RESISTOR, FIXED, COMPOSITION: 100 ohms ±5% 1/4 w Allen Bradley Type CB-1015 Stoddart No. 11693-101
R186	RESISTOR, FIXED, COMPOSITION: 10 ohms ±5% 1/4 w Allen Bradley Type CB-1005 Stoddart No. 11693-100
R187	RESISTOR, VARIABLE: 10,000 ohms Beckman Inst. Div. of Helipot Model 62-103 Stoddart No. 18546-103
R188	Same as R151
R189	Same as R176
R190	Same as R184
R191	Same as R150
R192	Same as R107
R193	Same as R135
R194	Same as R174
R195	Same as R176
R196	Same as R151
R197	Same as R181
R198	RESISTOR, FIXED, COMPOSITION: 33,000 ohms ±5% 1/4 w Allen Bradley Type CB-3335 Stoddart No. 11693-333
R199	Not used
R200	Same as R174
R201	RESISTOR, FIXED, COMPOSITION: 220,000 ohms ±5% 1/4 w Allen Bradley Type CB-2245 Stoddart No. 11693-224

SYMBOL	DESCRIPTION
R202	Same as R201
R203	RESISTOR, VARIABLE: 25,000 ohms ±10% 2 w Ohmite Type CU 2531 Stoddart No. 11733
R204	Not used
R205	RESISTOR, FIXED, COMPOSITION: 470,000 ohms ±5% 1/4 w Allen Bradley Type CB-4745 Stoddart No. 11693-474
R206	RESISTOR, VARIABLE: 1 megohm Bourns Trimpot Div. No. 276-1-105 Stoddart No. 18510-105
R207	Same as R206
R208	Same as R205
R209	RESISTOR, FIXED, COMPOSITION: 6.2 Megohms ±5% 1/4 w Allen Bradley Type CB-6255 Stoddart No. 11693-625
R210	RESISTOR, VARIABLE: 10,000 ohms Bourns Inc., Trimpot Div.No.275-1-103 Stoddart No. 18510-103
R211	Same as R210
R212	RESISTOR, FIXED, COMPOSITION: 3900 ohms ±5% 1/4 w Allen Bradley Type CB-3925 Stoddart No. 11693-392
R213	RESISTOR, FIXED, COMPOSITION 6,800 ohms, ±5%, 1/4 w Allen Bradley Type CB-6825 Stoddart No. 11693-682
R214 thru R217	Not used
R218	RESISTOR, VARIABLE: 20,000 ohms Bourns Inc., Trimpot Div. No.275-1-203 Stoddart No. 18510-203
R219	Same as R123
R220	Same as R151
R221	Same as R125
R222	Same as R212
R223	Same as R157
R224	Not used
R225	RESISTOR, FIXED, COMPOSITION: 820 ohms ±5% 1/4 w Allen Bradley Type CB-8215 Stoddart No. 11693-821
R226	RESISTOR, VARIABLE: 5000 ohms Bourns Trimpot Div. No. 275-1-502 Stoddart No. 18510-502

SYMBOL	DESCRIPTION
R227	RESISTOR, FIXED, COMPOSITION: 390 ohms ±5% 1/4 w Allen Bradley Type CB-3915 Stoddart No. 11693-391
R228	Not used
R229	RESISTOR (Selected):
R230	Same as R114
R231	Same as R107
R232	RESISTOR, FIXED, COMPOSITION: 2,200 ohms ±5% 1/4 w Allen Bradley Type CB-2225 Stoddart No. 11693-222
R233	Same as R184
R234	Same as R153
R235	Same as R201
R236	Same as R174
R237	Same as R135
R238	RESISTOR, FIXED, COMPOSITION: 620 ohms ±5% 1/4 w Allen Bradley Type CB-6215 Stoddart No. 11693-621
R239	RESISTOR, VARIABLE: 100 ohms Beckman Inst. Div. of Helipot Model 62-101 Stoddart No. 18546-101
R240	RESISTOR, FIXED, FILM: 1540 ohms ±1% 1/4 w Penn Resistor Corp. Type FCA10 Stoddart No. 18548-1540R
R241	RESISTOR, VARIABLE: 100,000 ohms ±10% 2 w Allen Bradley No. JA1N056P104AA Stoddart No. 11741
R242	RESISTOR, FIXED, COMPOSITION: 56,000 ohms ±5% 1/4 w Allen Bradley Type CB-5635 Stoddart No. 11693-563
R243	RESISTOR, FIXED, COMPOSITION: 330,000 ohms ±5% 1/4 w Allen Bradley Type CB-3345 Stoddart No. 11693-334
R244	Same as R114
R245	Same as R108
R246	Same as R184
R247	Same as R201
R248	Same as R107
R249	Same as R144
R250	Same as R108
R251	Same as R108

SYMBOL	DESCRIPTION
R252	Same as R108
R253	RESISTOR, FIXED, COMPOSITION: 470,000 ohms ±5% 1/4 w Allen Bradley Type CB-4735 Stoddart No. 11693-473
R254	Same as R201
R255	RESISTOR, FIXED, COMPOSITION: 22 ohms ±5% 1/4 w Allen Bradley Type CB2205 Stoddart No. 11693-220
R256	Same as R255
R257	RESISTOR, FIXED, COMPOSITION: 220 ohms ±5% 1/4 w Allen Bradley Type CB-2215 Stoddart No. 11693-221
R258	Same as R242
R259	Not used
R260	
thru	Not used
R265	
R266	Same as R114
R267	Same as R108
R268	Same as R176
R269	
thru	Not used
R271	
R272	RESISTOR, FIXED, COMPOSITION: 1 Megohm ±5% 1/4 w Allen Bradley Type CB-1055 Stoddart No. 11693-105
R273	Same as R205
R274	
thru	Not used
R278	
R279	Same as R130
R280	Same as R184
R281	Same as R119
R282	Same as R181
R283	
thru	Not used
R305	
R306	RESISTOR, FIXED, COMPOSITION: 7500 ohms ±5% 1/4 w Allen Bradley Type CB-7525 Stoddart No. 11693-752

SYMBOL	DESCRIPTION
R307 thru R313	Not used
R314	RESISTOR, FIXED, WIREWOUND 20 ohms, ±5%, 3 w Sprague Type 242E, ±5% tol. Stoddart No. 12574-200
R315	RESISTOR, FIXED, COMPOSITION 2,000 ohms, ±5%, 1/2 w Allen Bradley Type EB-2225 Stoddart No. 10011-222
R316	RESISTOR, FIXED, COMPOSITION: 100 ohms ±5% 2 w Allen Bradley Type HB-1015 Stoddart No. 10377-101
R317	RESISTOR, FIXED, COMPOSITION: 27 ohms ±5% 1/4 w Allen Bradley Type CB2705 Stoddart No. 11693-270
R318	RESISTOR, VARIABLE: 200 ohms Bourns Trimpot No. 275-1-201 Stoddart No. 18510-201
R319	RESISTOR, FIXED, COMPOSITION: 1.5 Megohm ±5% 1/4 w Allen Bradley Type CB-1555 Stoddart No. 11693-155
R320	RESISTOR, FIXED, FILM: 4,750 ohms ±1% 1/8 w Stoddart No. 12308-475
R321	Same as R122
R322	Same as R112
R323	RESISTOR, FIXED, COMPOSITION: 2,000 ohms ±5% 1/4 w Allen Bradley Type CB-2025 Stoddart No. 11693-202
R324	RESISTOR, VARIABLE: 500 ohms Bourns Trimpot No. 275-1-501 Stoddart No. 18510-501
R325	Same as R181
R326	Same as R123
R327	
thru	Not used
R400	
R401	RESISTOR, FIXED, FILM: 245 ohms ±1% 1/2 w Dale-Ohm Type DCS-1/2 Stoddart No. 12298-245R
R402	RESISTOR, FIXED, FILM: 495 ohms ±1% 1/2 w Dale-Ohm Type DCS-1/2 Stoddart No. 12298-495R
R403	Same as R402
R404	Same as R402

SYMBOL	DESCRIPTION
R405	RESISTOR, FIXED, FILM: 448 ohms ±1% 1/2 w Dale-Ohm Type DSC-1/2 Stoddart No. 12298-448R
R406	RESISTOR, FIXED, FILM: 59.8 ohms, ±1% 1/2 w Dale-Ohm Type DCS-1/2 Stoddart No. 12298-59R8
R407	RESISTOR, FIXED, FILM: 68.6 ohms ±1% 1/2 w Dale-Ohm Type DCS-1/2 Stoddart No. 12298-68R6
R408	RESISTOR, FIXED, FILM: 61.1 ohms ±1% 1/2 w Dale-Ohm Type DCS-1/2 Stoddart No. 12298-61R1
R409	Same as R408
R410	Same as R408
R411	RESISTOR, FIXED, FILM: 55 ohms ±1% 1/2 w Dale-Ohm Type DCS-1/2 Stoddart No. 12298-55RO
RT103	THERMISTOR: Victory Engineering Corp. Type 28D13, 750 ohms Stoddart No. 18614
S101	SWITCH, ROTARY: Attenuator Switch Stoddart No. 12296
S102A/B	SWITCH, 2 POLE MICRO: Microswitch Co. No. 11SM23 Stoddart No. 18536
S103A/H	SWITCH, ROTARY: Function Switch, 5 position Stoddart No. 11756
S104	Not used
S105	SWITCH,TOGGLE: SPDT,(AGC, Meter F/S) C+K Components Type 7101 Stoddart No. 18544
S106A/B	Same as S102
S107	Not used
S108A/D	SWITCH, ROTARY: 4P3T Stoddart No. 18324
S109	Same as S105
S110	SWITCH, TOGGLE, BANDWIDTH: Microswitch Inc. No. 23AT1 Stoddart No. 18393
S111 thru S301	Not used

SYMBOL	DESCRIPTION
S302	SWITCH, TOGGLE: DPDT Arrow-Hart & Hegeman No. 83054 Stoddart No. 10172
S303 thru S400	Not used
S401A/G	SWITCH, ROTARY: 7 Section, Tuner Switch Stoddart No. 18623
T101	TRANSFORMER, RF P/O RF Tuner Stoddart No. 94419-1
T102	TRANSFORMER, RF: P/O RF Tuner Stoddart No. 94420-1
T103	TRANSFORMER, RF P/O RF Tuner Stoddart No. 94421-1
T104	TRANSFORMER, RF: P/O RF Tuner Stoddart No. 94422-1
T105	TRANSFORMER, RF: P/O RF Tuner Stoddart No. 94423-1
T106	TRANSFORMER, RF: P/O RF Tuner Stoddart No. 94424-1
T107	TRANSFORMER, RF: P/O RF Tuner Stoddart No. 94425-1
T108	TRANSFORMER, RF P/O RF Tuner Stoddart No. 94426-1
T109	TRANSFORMER, RF: P/O RF Tuner Stoddart No. 94076-1
T110	TRANSFORMER, RF: P/O RF Tuner Stoddart No. 94427-1
T111	TRANSFORMER, RF: Pre-Amp. Trans. Stoddart No. 94056-1
T112	TRANSFORMER, RF: Pre-Amp. Trans. Stoddart No. 94057-1.
T113	TRANSFORMER, RF: Pre-Amp. Trans. Stoddart No. 94058-1
T114	TRANSFORMER, RF: Pre-Amp. Trans. Stoddart No. 94059-1
T115	TRANSFORMER, RF: Pre-Amp. Trans. Stoddart No. 94060-1

SYMBOL	DESCRIPTION
T116	TRANSFORMER, RF: Pre-Amp. Trans. Stoddart No. 94061-1
T117	
thru	Not used
T139	
T140	TRANSFORMER, IF: IF Input Trans. Stoddart No. 93956-1
T141	TRANSFORMER, IF: 1st IF Amp. Trans. Stoddart No. 93957-1
T142	TRANSFORMER, IF: 2nd IF Amp. Trans. Stoddart No. 93958-1
T143	TRANSFORMER, IF: 3rd IF Amp. Trans. Stoddart No. 93959-1
T144	TRANSFORMER, IF: 2nd IF Output Trans. Stoddart No. 93960-1
T145	TRANSFORMER, RF: Osc. Main IF Stoddart No. 93961-1
T146	TRANSFORMER, RF: B.F.O. Trans. Stoddart No. 93931-1
T147	TRANSFORMER, IF: IF Amp. Trans. Stoddart No. 93263-1
T148	
thru	Not used
T301	
T302	TRANSFORMER, POWER: 115 v. -220 v., to 225.5 v. sec. Axtec No. 2605 Stoddart No. 18513

RADIATION HAZARDS
IN RADIO INTERFERENCE MEASUREMENT

1. Biological damage from exposure to intense RF radiation has been known for several years but only recently have quantitative limits been established.

2. A tri-service limit for exposure to RF radiation has been established at .01 watts/cm^2 at any frequency. This is 194 volts/meter assuming linearly polarized plane waves. General Electric has proposed that a maximum safe limit of .001 watts/cm^2 (61 volts/meter) be used for continuous exposure and that .01 watts/cm^2 be an absolute maximum not to be exceeded except under emergency conditions.

3. It is possible that personnel operating Stoddart equipment will be exposed to power densities greater than .01 watts/cm^2. This will probably occur in locations where the rf field will not be linearly polarized plane waves such as the Fresnel Zone and in close proximity to magnetrons and klystrons.

4. It is suggested that before taking measurements near suspected or known strong radiation sources that reliable information on intensity be obtained.

Direct measurements of strong signal sources can be made with RI-FI equipment if the frequency is in the tuning range. Most RI-FI equipment does not have sufficient voltage range or shielding effectiveness to accurately measure to 194 volts/meter using standard antennas. In some situations, involving concentrated fields, the use of loop probes with their large antenna factors would enable approximate measurement. Limitations in RI-FI equipment shielding sometimes permits full scale meter indication when tuned to a very strong signal even with the antenna disconnected. Needless to say, the operator should be concerned when this occurs.

The following chart provides approximate equipment range limits (full scale) in volts/meter with and without pickup devices.

The equipment would be standardized for gain in accordance with instructions on the charts supplied. Then the input attenuator should be placed in the maximum position. Continuous wave signals would be measured in FI function switch position. Pulsed signals are measured with PEAK function.

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Equipment	Antenna	Approximate field strength volts/meter Equivalent radiation levels given in table below
NM-10A	Half meter rod	2
	30" loop (90117-2)	10
(14 kc to 250 kc)	6" loop (90114-2)	100
	Loop probe (90185-1)	1000*
	No antenna (or cable)	100 to 200
NM-20B	41" rod (90291-2)	2
	Loop antenna (90298-2)	.1
(150 kc to 25 mc)	Loop probe (90185-2)	10*
	No antenna (or cable)	20
NM-30A	Tuned dipole	1 to 50
	Loop antenna (90799-2)	170 to 500*
(20 mc to 400 mc)	No antenna (or cable)	10 to 500
NM-50	Tuned dipole	30 to 180
(375 mc to 1000 mc)	No antenna (or cable)	100 to 180

Field Strength volts/meter	Radiation Level watts/cm^2
0.1	0.265×10^{-8}
2.0	1.06×10^{-6}
10.	0.265×10^{-4}
20	1.06×10^{-4}
30	2.39×10^{-4}
50	6.63×10^{-4}
100	0.265×10^{-2}
170	0.766×10^{-2}
180	0.86×10^{-2}
200	1.06×10^{-2}
500	6.63×10^{-2}
1000	0.265

$$P = \frac{(E)^2}{120\pi} = .00265(E)^2 \frac{\text{watts}}{(\text{meter})^2}$$

P = Radiation Level
E = Field Strength - $\frac{\text{volts}}{\text{meter}}$

$$P \frac{(\text{watts})}{cm^2} = 10^{-4} \times P \frac{(\text{watts})}{(\text{meter})^2}$$

* Maximum measurement shown using loop probe antenna is only practical if RI-FI equipment is not exposed to strong RF field.

ENGINEERING DEPARTMENT
October 27, 1965

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2045 West Rosecrans Avenue
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STODDART NO. 40019-A